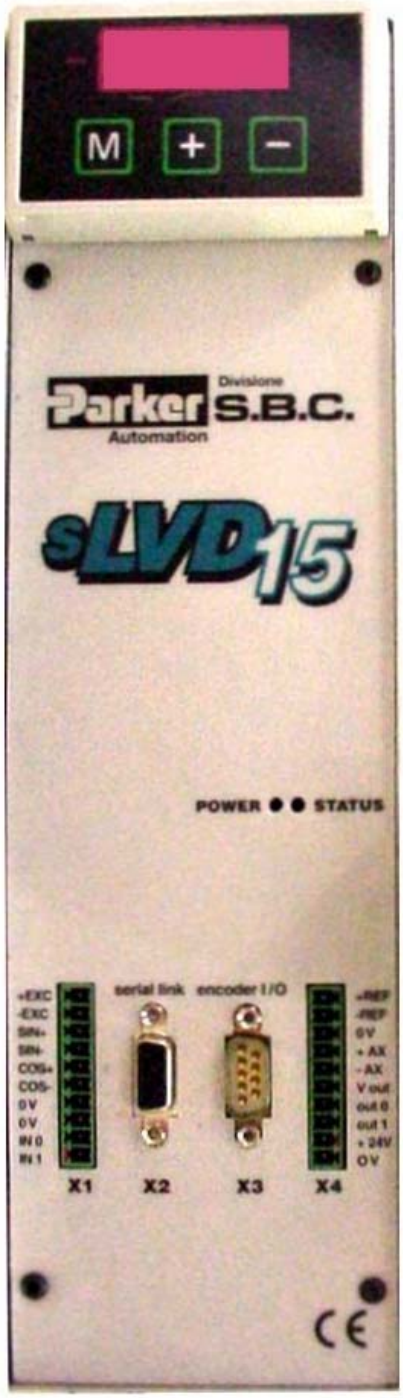
Parker Divisione S.B.C.



sLVD

sLVD1 sLVD2
sLVD5 sLVD7
sLVD10 sLVD15

User Manual

rev. 2.6
July 2004
(software rel. 21)

DECLARATION OF CONFORMITY

The Manufacturer: Parker Hannifin S.p.A. – Divisione S.B.C.

address of the manufacturer: via Gounod, 1
20092 - Cinisello Balsamo (Milano)
Italy

declares that the products:

name of the products sLVD1, sLVD2, sLVD5, sLVD7. sLVD10, sLVD15

satisfy the following product specifications:

Safety: EN50178, EN60065

EMC: immunity: EN50082-1
EN50082-2
IEC1000-4-2 Level 3
IEC1000-4-3 Level 3
IEC1000-4-4 Level 4

emission: EN50081-1
EN50081-2
EN55011 Group 1, Class A, Class B

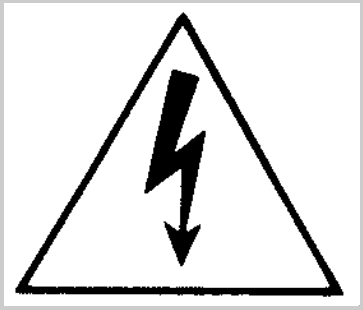
Additional notes:

The products listed meet the requirements of Directive 73/23/EEC amended by 93/68/EEC.
The products have been verified under a typical configuration.
The products must be installed keeping strictly to the directions for use explained in their instruction manual.

Cinisello B., Milano, the 30th of September 1998

Ottorino Salvalai
Managing Director

DANGER



HIGH VOLTAGE!

Some internal circuits of the ***SLVD*** converter are subject to voltages that can create serious danger for individuals and they can even cause death.

The converter must not be accessed when it is powered-on.
Whenever it is necessary to access it, be sure it has been powered off for fifteen minutes to allow the condensers to discharge. The user must make sure that the device has been installed in accordance with the workplace safety regulations currently in force.
In this regard, note that the converter is to be considered a component, not a machine.

Any unauthorized repair or tampering with the device invalidates the warranty immediately. The device is under warranty for one year.

This user manual is for the standard version of the converter.

Parker Hannifin S.p.A. Divisione S.B.C. declines any responsibility for any type of damage that may be caused by the inappropriate use of the converter.

Only qualified and trained personnel who have a basic knowledge of electronics may install and carry out maintenance operations on the converter and the devices connected to it.

Only qualified and trained personnel with a good knowledge of electronics and converter technology is allowed to commissioning.

Upon request, Parker Hannifin S.p.A. Divisione S.B.C.offers training courses.

The performance of SLVD converter is guaranteed only with synchronous motors with permanent magnets MB and SMB Series that have been manufactured by us.

ISBN 0407021500

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1 INTRODUCTION

1.1 General information

This manual describes the installation and commissioning of the frequency converter SLVD for brushless motors.

Read **carefully** all the sections and the history of the revision of the manual on the final page before using it.

1.2 Product description

The SLVD is a digital frequency converter for brushless motors. The operator interface based on parameters makes it easy to configure the converter. Configurations of different kinds make suitable it for many applications.

The power of the 16-bit micro-controller is used to control the speed as required for a servo controller and it also offers a series of additional functions that can reduce the control electronics in the application with obvious cost savings.

The SLVD provides functions as a positioner with a trapezoidal profile, electrical shaft, electronic cams, spindle orientation, simulator of a step motor and torque control, and it also contains a PLC. It uses widely diffused industrial programming standards and guarantees a high degree of freedom in selecting inputs and outputs. The SLVD also offers the possibility to develop additional functions that are not included in the basic functionality of the converter such as gain correction for loops based on speed or space, monitoring the used torque for tool life control, etc.

The SLVD is equipped with a RS-422/RS-485 serial interface which is used to configure, monitor, and send commands to up to 32 SLVDs at the same time. Standard operator panels can be connected to support the SBC protocol.

A CanBus interface is also available which can be used in *communication mode* and also in *real time mode*. The CanBus can be used to set up a wide-band digital link, thereby simplifying the cabling of the system.

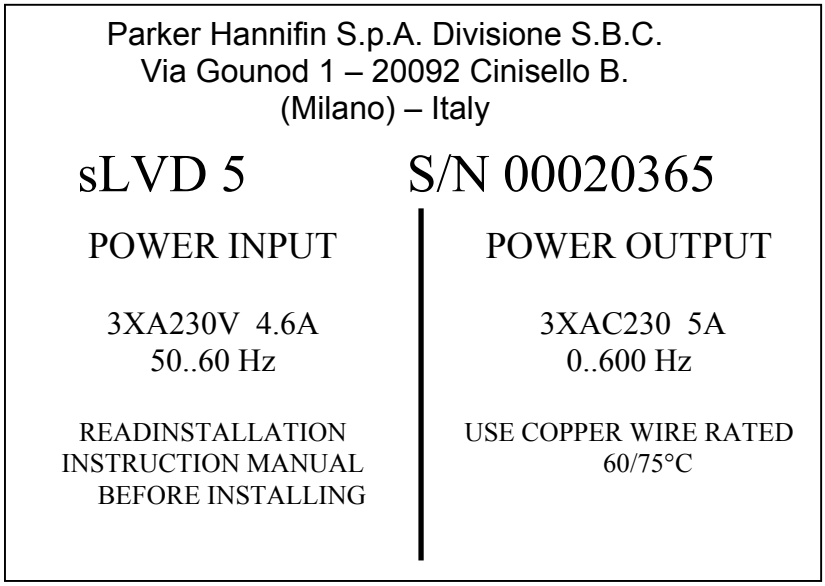
1.3 Identification

The converters of the SLVD series are available in six models: SLVD1, SLVD2, SLVD5, SLVD7, SLVD10 and SLVD15. The number that follows the SLVD abbreviation corresponds to the rated current of the converter in amperes.

A label is attached on the right side of the SLVD converter that contains all the essential informations to correctly identify the unit.

It is important to refer to this label before requesting any kind of technical information from Parker Hunnifin S.p.A Divisione S.B.C.

An example of this label is given below.



1.4 Main hardware features

Item	***Unit of measurement***	***Value***					
Power Supply	V~	230 ± 10%					
Control Voltage	V=	24 ± 10%, 1 A					
Models		sLVD1	SLVD2	SLVD5	SLVD7	sLVD10	sLVD15
Rated Output Current	A	1,25	2,5	5	7	10	15
Peak Output Current (4 s)	A	2,5	5	10	14	20	30
Shaft Power	kW	0,345	0,7	1,5	2,2	3	4,5
Control Electronics Dissipation	W	18					
Power Stage Dissipation	W	18	28	45	65	87	120
Ambient Temperature	°C	45					
Braking Resistor	internal/external (PR option, standard on 7,10 e 15)						
Internal Braking Resistor Dissipation	W	60					
Feedback	resolver (speed 1)						
Power Stage Switching Frequency	kHz	8					
Maximum Output Fundamental Frequency	Hz	450					
Protection	IP 20						
24 V Digital Inputs	N°	2+2					
24 V / 100Ma / PNP Digital Outputs	N°	2					
Encoder Simulation RS-422	steps/rev	4…2500					
Frequency / sign or Encoder Input	kHz	800 / 200					
Analogue Reference	V	±10 differential					
Auxiliary Analogue Input	V	±10 differential					
Auxiliary Analogue Output	V	± 4,5					
Serial link	RS-422 / RS-485						
Field bus	CanBus ISO/DIS11898						

1.5 Main software features

The following functions have been implemented in the basic software of the SLVD:

- Speed controller
- Advanced manager of torque limits
- Management of speed windows
- Carries out positioning with a trapezoidal speed profile
- Provides the functions of an electrical shaft with variable ratio and phase correction
- Provides the functions of an electronic cam
- Simulates a stepper motor
- Controls the motor torque with the addition of speed control
- The internal PLC can be programmed to manage inputs and outputs

1.6 Conformity to EMC standards

Immunity:

EN50082-1* / EN50082-2	Basic immunity specifications
IEC1000-4-2 (ex IEC 801-2)	level 3 Immunity for electrostatic charge
IEC1000-4-3 (ex IEC 801-3)	level 3 Immunity for electromagnetic field
IEC1000-4-4 (ex IEC 801-4)	level 4 Immunity for fast transmission burst

Compatibility:

EN50081-1* / EN50081-2	Basic specifications for radio interference
EN55011 group 1, class A	Limits of measurement for radio interference
EN55011 group 1, class B*	Limits of measurement for radio interference

1.7 Safety

Safety regulation	EN60065, EN50178
Low voltage regulation	73/23/CEE modified by 93/68/CEE
Applied regulation	EN60204-1

- Conformity to the residential or industrial environment depends on the installation.

1.8 Data for the UL certification

The drive could be installed in the environments of type: Pollution degree 2, like suitable from the UL norm 508C, Par. 35.9.4a1.

Data of the nraking resistance:

DRIVE	Max current [Amps]		Max Duty Cycle [%]	Power [W]	Min resistance D.B.U. [Ω]
	Peak	Rms			
sLVD**1**,**2**,**5**,**7**	11	0,14	1,2	60	40

2 INSTALLATION

- The SLVD converter must be mounted vertically with the power block above using an omega guide.
- A space of at least 100 mm. Must be left free above and beneath the converter.

2.1 Safety instructions

- Make sure that the converter is sized properly for the motor it will be used with. Compare the rated voltages and currents.
- Connect the cabinet/converter/motor in accordance with the instructions that are given in this section, with the regulations for electromagnetic compatibility and with the safety regulations that are in force.
- The user is responsible for the protection fuses in the AC power supply of the converter.
- The power cables and the control cables must be separated by at least 20 cm. If they must be crossed, they must be crossed at a right angle. The motor cables and the power cables can never be parallel.
- All power cables must have a sufficient section (see the table given in paragraph 2.7) and must conform to the IEC227-2 regulation.
- The cables connected to the converter at the terminal cannot be consolidated with tin-lead welding (EN60065, Art.15.3.5).
- Make sure that the converter and the motor are correctly grounded.
- Make sure the maximum power at terminals L1, L2, and L3 does not exceed by more than 10% the rated voltage even in the worst case (see EN60204-1, section 4.3.1). Excessive supply voltage can damage the converter.
- Do not ever remove the electrical connections from a live converter.
- Follow carefully the instructions given in this manual step by step during the installation. If you have questions or problems, contact our customer assistance service.
- After power supply has been disconnected and the converter has been off for 60 seconds, dangerous voltage levels may persist. Do not touch any power cable during this time.
- Do not ever open the converter. This is dangerous and invalidates the warranty.

The installation and cabling operations must be done when there is absolutely no voltage in the entire electric cabinet. Make sure that the power switch on the converter is cut off from the emergency circuit. The first time the cabinet is powered up, qualified technical personnel must be present.

2.2 How to suppress interference

For the drive to meet the product requirements regarding electromagnetic compatibility, the installation must be carried out according to the following instructions.

Because of strong PWM voltage fronts, undesirable currents of significant force can sometimes circulate through capacitive couplings and grounding systems (conducted interference). Besides, also high frequency interferes in the form of radiation, especially through the motor cable, in free space are generated (radiated interference).

The reduction/suppression of both conducted and radiated interference can be obtained through grounding, shielding and filtering. In particular filters reduce the interference conducted in the cables and the return of interference conducted at the source (the frequency converter) by using paths with the lowest possible impedance. In this way other systems connected to the same electrical line can be protected effectively and the frequency converter will also be protected from the interference of other systems.

Basically, the criteria are essentially based on grounding, filtering and shielding.

2.2.1 Grounding

In the electric panels where the drives are usually installed there are two ground systems:

- EMC ground, or HF reference (high frequency), represented by the wall made of non-painted metal, onto which drives and filters are fixed.
- The safety ground, or PE (protective earth), according to the EN60204-1 standard

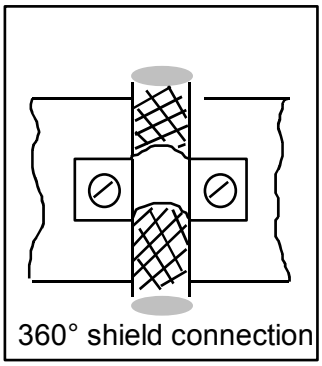
Fix drive and mains filters, the 24Vdc power supply etc. on the metal wall, making sure that there is a proper electric contact (HF connection).

Carry the safety ground using cables having a minimum section of 10mm²

Cable connections and shielding

With the exception of mains cables to the filter, all power and control cables must be shielded and, wherever possible, kept segregated (minimum distance 20 cm). If control and power cables must cross, the intersection must be at a right angle.

The shielded cables must be unbroken and grounded to a copper bar using the cable clamps connections as shown in the drawing (at 360º) in order to obtain a good conductivity.



In general the shield should be connected at each extremity. In certain circumstances, however, control cable shields may be connected only at one end to eliminate mains hum that could interfere with the control signal. Decide case by case as numerous factors must be considered. Adopt the following general approach: if the screen is solely for shielding, connect at both ends. If current flowing in the shield interferes with the shielded signals, connect at one end only.

The incoming cable must be connected to an earth terminal by means of a screw to ensure proper contact between screen and earth.

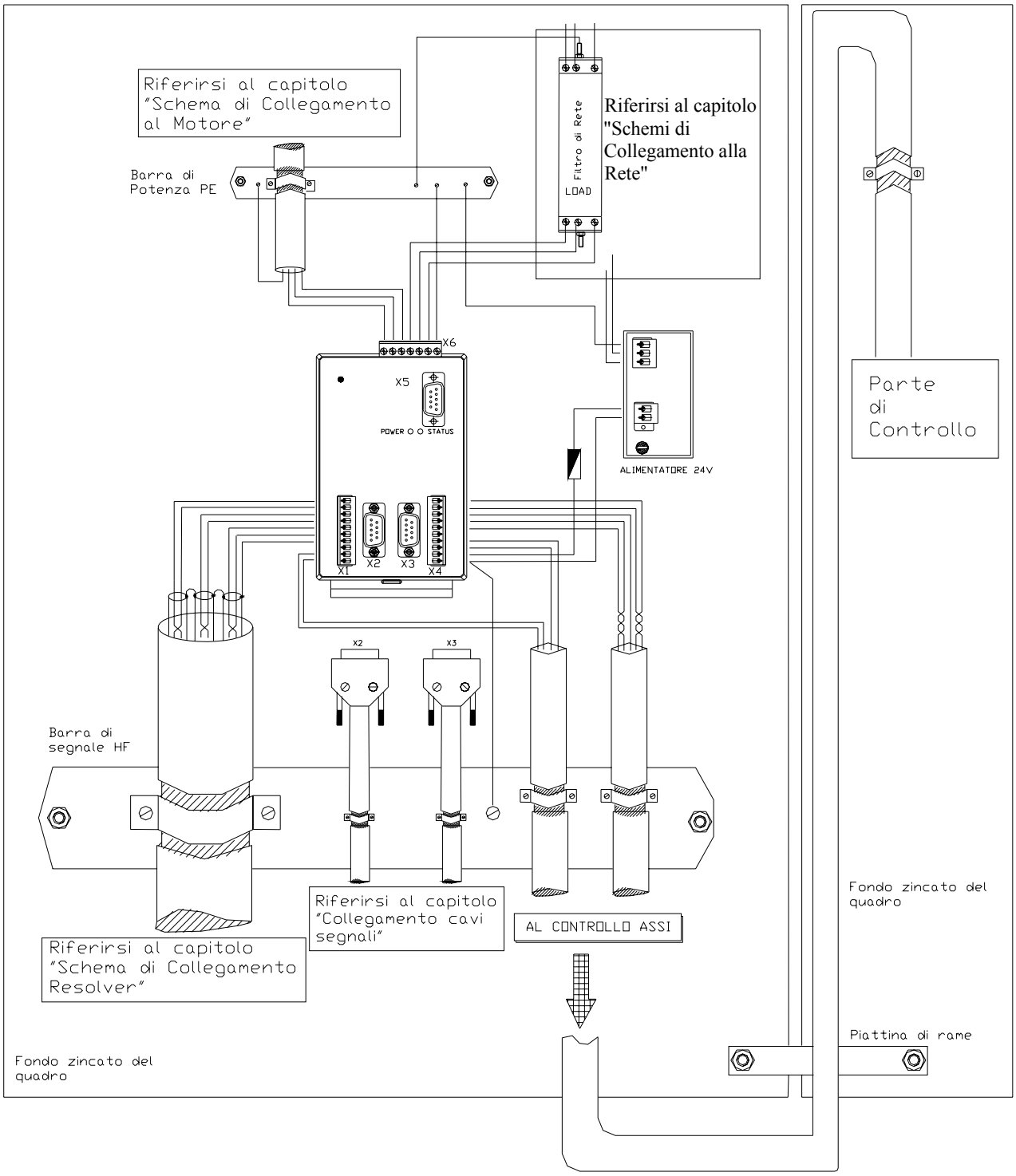
As far as possible keep the power side (drive) and control side (PLC or NC) physically separated by separating the metal mounting plates. Inside the electrical cabinet, the two plates must be connected through a copper strap.

General suggestions on cable connections

Avoid routing noise emitting cables in parallel with "clean" cables
Avoid parallel cables, especially in the vicinity of the filter (ensure physical separation)
Avoid cable loops (keep cables as short as possible and close to the common potential).

In particular, keep the main cables separate from motor cables.

If the motor is of the embedded brake type, keep the 24Vdc brake cables separate from the other cables (resolver and motor).



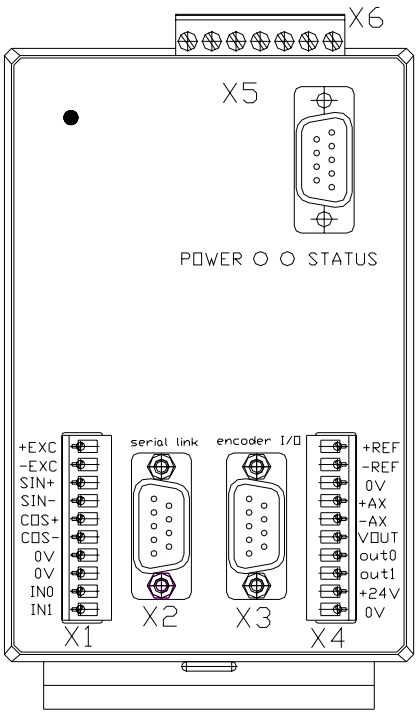
* The PE bar (for power grounding) must be mounted directly in contact; insulated columns are not to be used.
** The signal cable shields can be connected to a bar (HF) different from the PE bar or connected directly the metallic cable clamps to electrical cabinet back-plate.
*** In the "Cable connections" par. it is possible see every detail of this image.

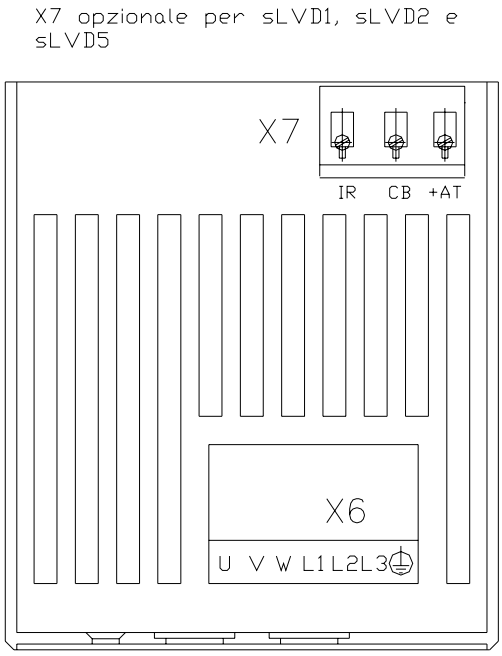
2.2.2 Mains and motor side filters

It is usually necessary to use external filters in addition to internal filters the drive is provided with, on the mains input and sometimes on the motor output.
The mains filter must be mounted as close as possible to the drive and on the same drive panel, and must have a large area of contact with the power panel or the mounting plate.
If distance exceeds 30cm, the effect decreases and a screened cable must be used between filter and converter.
The filter earth terminal must be connected to the earth bar along the shortest possible route.
Ferrite toroids are generally used for the motor output, with multiple turns obtained by winding the 3 motor cables contemporarily.

2.3 Signal connectors layout

2.3.1 Connectors layout sLVD1, sLVD2, sLVD5 and sLVD7





Terminal 3 pin X7 (optional)	
1	IR
2	CB
3	+AT

10 pole terminal (left) X1	
1	+ ECC
2	- ECC
3	SIN +
4	SIN -
5	COS +
6	COS -
7	0 V
8	0 V
9	IN 0
10	IN 1

DB9 female poles X2 links	
1	TX
2	RX
3	/TX
4	/RX
5	CANH
6	+BR180
7	- BR180
8	CANL
9	0V

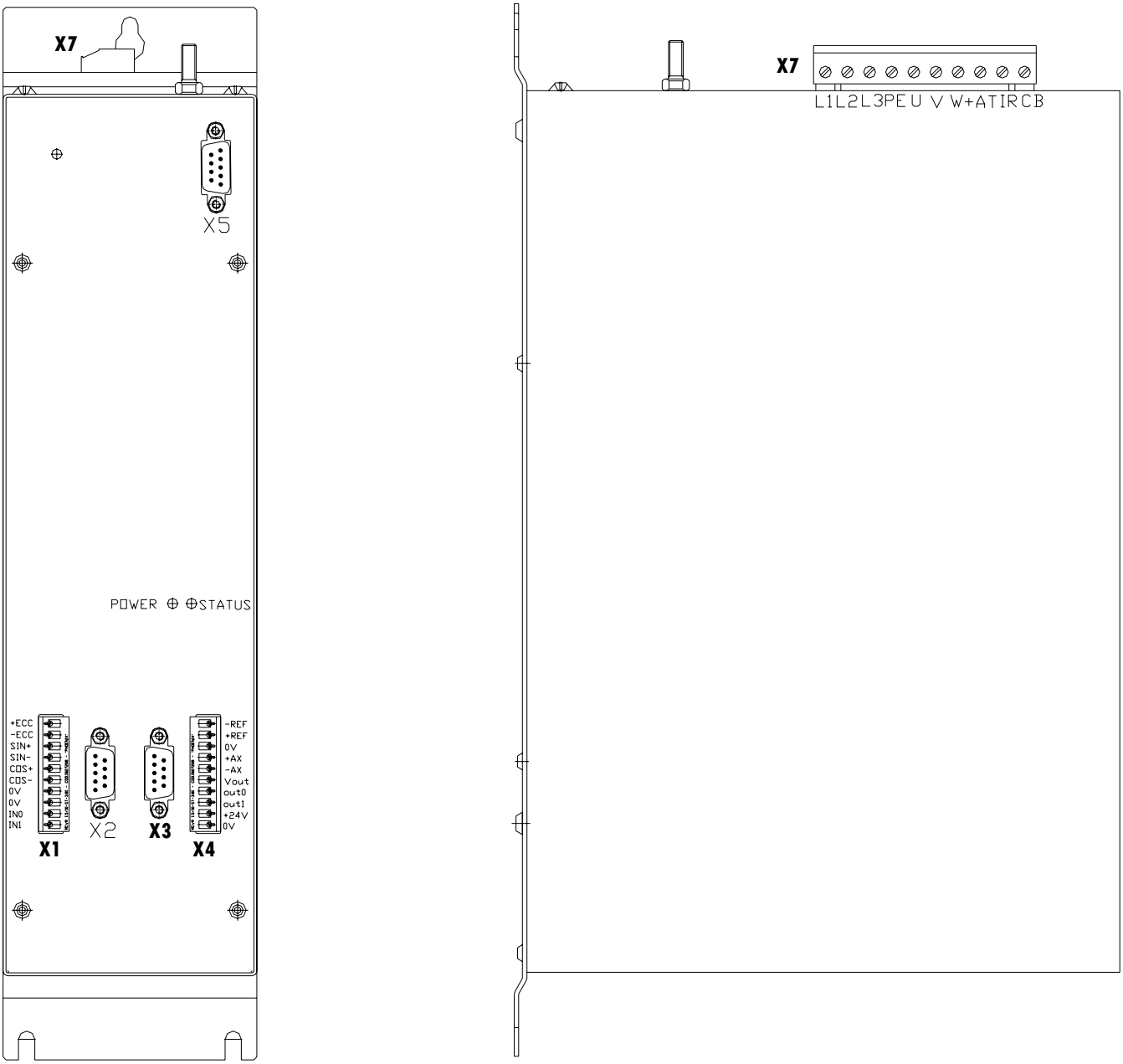
DB9 male poles X3 encoder in/out	
1	PHA
2	/PHA
3	PHB
4	/PHB
5	PHC
6	/PHC
7	0V
8	
9	

10 pole terminal (right) X4	
1	ANALOGUE REFERENCE +
2	ANALOGUE REFERENCE -
3	0 V
4	AUXILIARY ANALOGUE INPUT +
5	AUXILIARY ANALOGUE INPUT -
6	V OUT
7	OUT 0 / IN 2
8	OUT 1 / IN 3
9	+ 24 V
10	0 V

DB9 female poles X5 keyboard	
1	**Connector for**
2	
3	
4	**the programming keyboard**
5	
6	
7	
8	
9	

7 pole terminal (top) X6 "power"	
U	MOTOR PHASE U
V	MOTOR PHASE V
W	MOTOR PHASE W
L1	LIVE 1
L2	LIVE 2
L3	LIVE 3
PE	PE

2.3.2 Connectors layout sLVD10 and sLVDd15



10 pole terminal (left) X1	
1	+ ECC
2	- ECC
3	SIN +
4	SIN -
5	COS +
6	COS -
7	0 V
8	0 V
9	IN 0
10	IN 1

DB9 female poles X2 links	
1	TX
2	RX
3	/TX
4	/RX
5	CANH
6	+BR180
7	- BR180
8	CANL
9	0V

DB9 male poles X3 encoder in/out	
1	PHA
2	/PHA
3	PHB
4	/PHB
5	PHC
6	/PHC
7	0V
8	
9	

10 pole terminal (right) X4	
1	ANALOGUE REFERENCE +
2	ANALOGUE REFERENCE -
3	0 V
4	AUXILIARY ANALOGUE INPUT +
5	AUXILIARY ANALOGUE INPUT -
6	V OUT
7	OUT 0 / IN 2
8	OUT 1 / IN 3
9	+ 24 V
10	0 V

DB9 female poles X5 keyboard	
1	**Connector for**
2	
3	
4	**the programming keyboard**
5	
6	
7	
8	
9	

7 pole terminal (top) X7 "power"	
L1	LIVE 1
L2	LIVE 2
L3	LIVE 3
PE	PE
U	MOTOR PHASE U
V	MOTOR PHASE V
W	MOTOR PHASE W
+AT	+BUS
IR	INT-RES
CB	COM-BRK

2.4 Connections

Motor cable

A choice shall be made between a cable for flexible or static installation.

The cable must be shielded and sized properly in terms of insulation and sections. It should be made of reticular polypropylene. Once the length is decided upon (maximum length is 35 m), the conductor-conductor capacity cannot exceed 8 Nf. The minimum cross section of the conductors must be 1.5 mm^2.

Power supply cable

The cables cannot be shielded. The minimum section of the conductors must be 1.5 mm^2. The fuses at the input must have the following values:

MODEL	***Slow-blow fuses (A)***
sLVD1sLVD2	6
sLVD5	10
sLVD7	14
sLVD10	16
sLVD15	20

A thermo-magnetic switch properly chosen depending on the power cables used can be used instead of fuses.

Resolver cable

The cable must consist of three individually shielded and insulated twisted pairs protected by a shield. The conductor-conductor capacity for the length used cannot exceed 10 Nf and the section cannot be less than 0.22 mm^2. The maximum length is 35 m.

The 24V Power supply

It must deliver at least 1A for each drive connected with 1Vpp max ripple voltage.
It must be reserved to the drive supply only. In fact, the use of just one 24V power supplier for e.g. brakes, relays etc. may generate electrical noises and or malfunctions.

Connect of an EMI filter, if any

If the unit is connected directly to the 230 V mains, the length of the cable between the sLVD and the filter cannot exceed 50 cm. In order to obtain the maximum effectiveness. If an auto-transformer is used, the filter can be installed either upstream or downstream from the auto-transformer. In this case the cable used for the connection between the transformer and the sLVD must be shielded.

Ground connections

It is necessary to minimize the length of the individual cables to be grounded. For this reason we recommend that a grounding bar be placed as close as possible to the frequency converters.

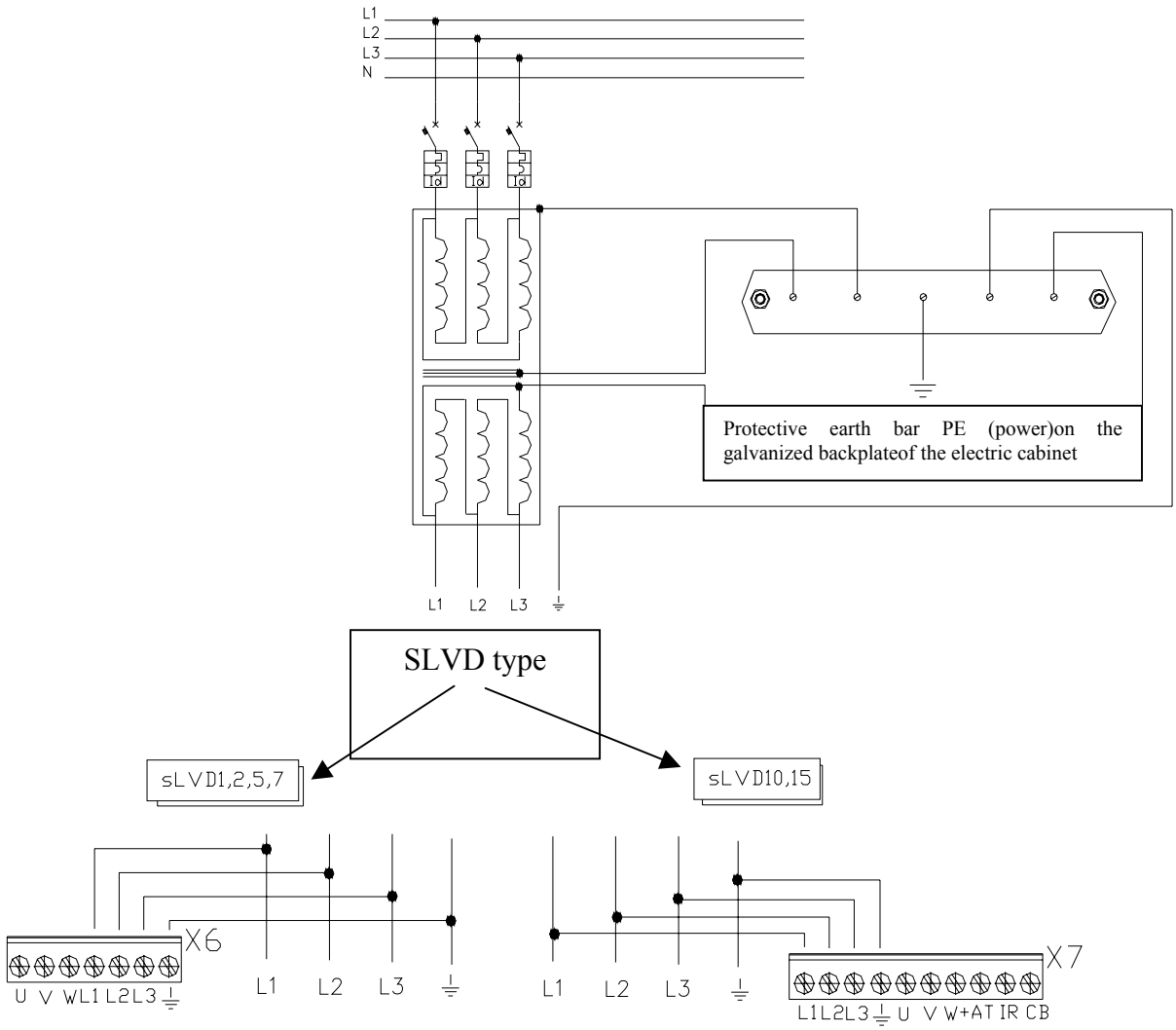
The grounding bar must be made of low inductance copper and must be mounted on electrical cabinet back-plate (pls. ensure good electrical contact by removing paint, if any). The table shows the minimum dimensions vs. length.

Length (m)	***Width (mm)***	***Thickness (mm)***
0.5	20	6
1	40	6
1.5	50	6

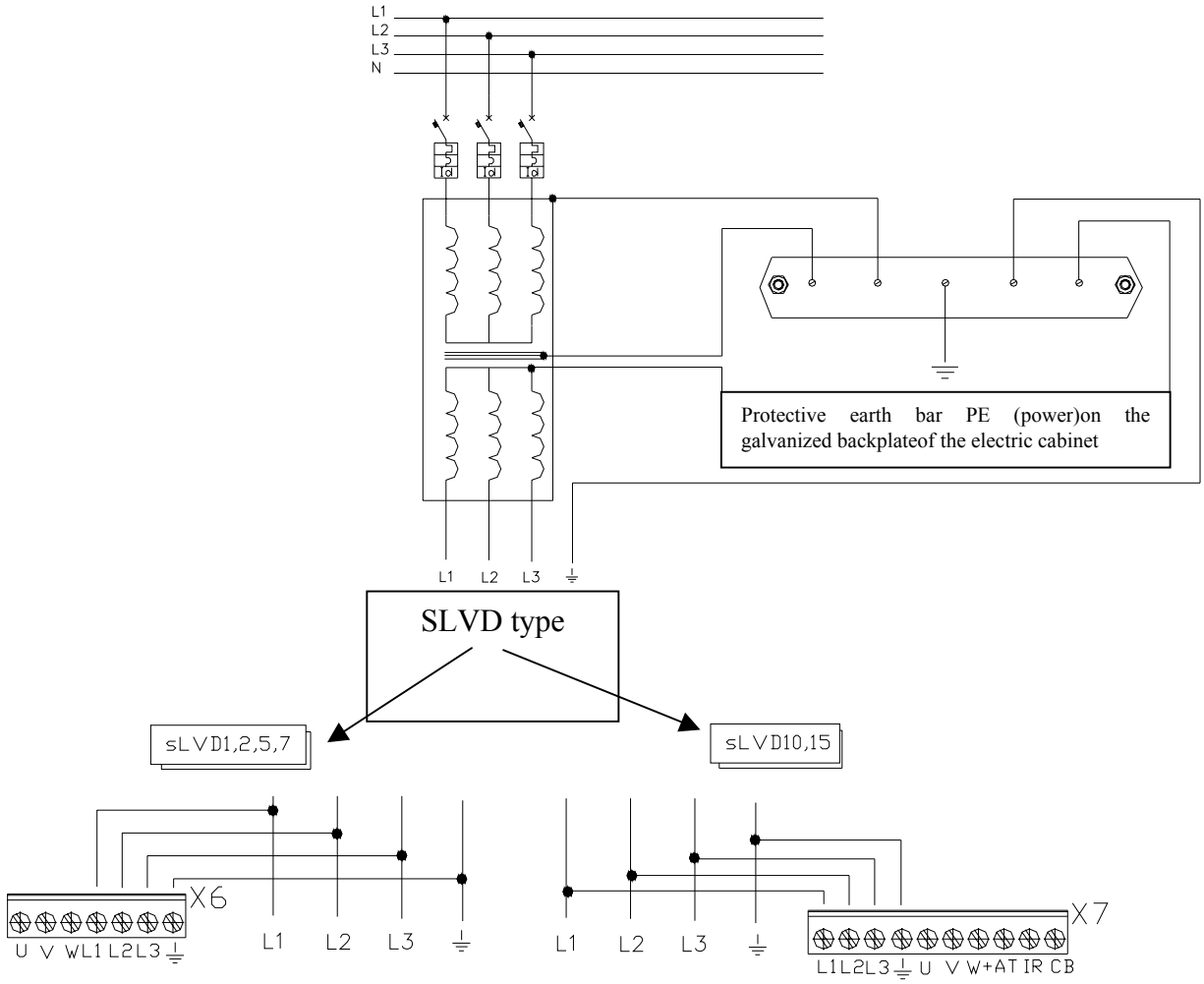
2.5 Line connection diagrams

The sLVD converter can be connected to the power supply in various ways.
If a transformer with an electrostatic shield between the primary and the secondary is used, EMC filters will not have to be installed. If an auto-transformer, a transformer without electrostatic shield or a direct connection to the power network is used, EMC filters must be used.

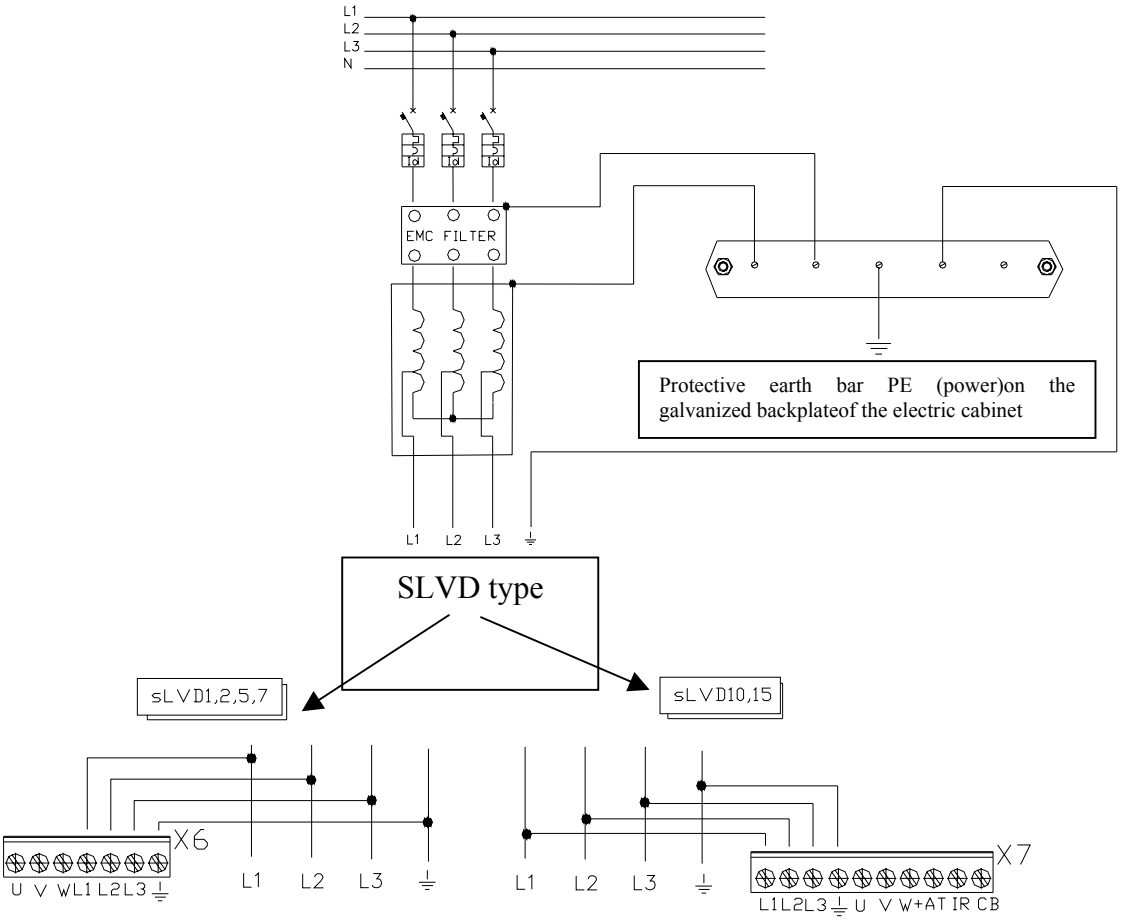
Use of a transformer connected in a triangle configuration with a primary and secondary electrostatic shield



Use of a transformer connected in a star configuration with a primary and secondary electrostatic shield



Use of the auto-transformer



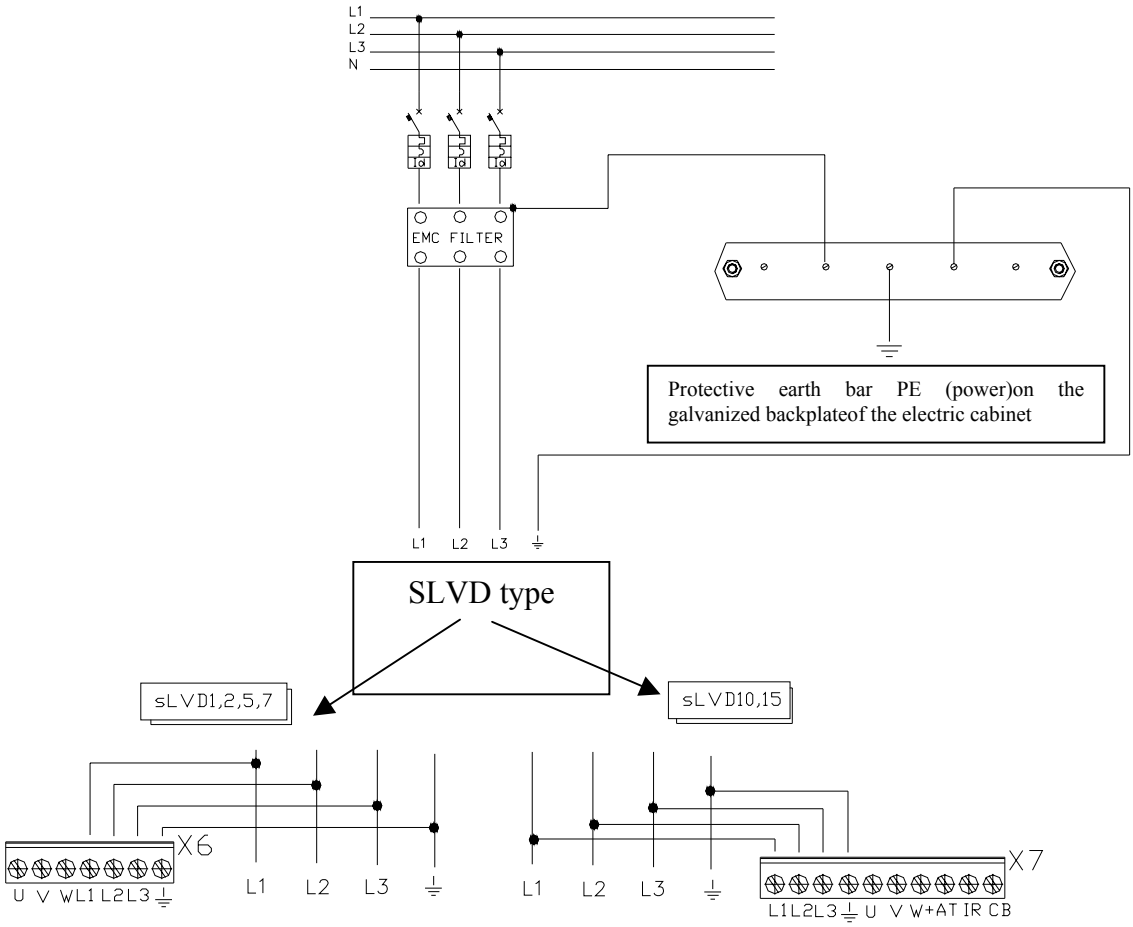
Note:
The EMC filter can be connected upstream or downstream from the auto-transformer. If it is connected upstream, it may be necessary to use a shielded cable between the auto-transformer and the sLVD. If it is connected downstream, the cable between the filter and the sLVD must be as short as possible and it cannot exceed 50 cm.

Use the following formula to dimension the transformer:

$$Pt = \left(Paz \cdot 1.7 + 80\right) \cdot \frac{1.73}{\sqrt{n+2}}$$

where **Pt** is the power in VA of the transformer, **Paz** is the sum of the rated powers of the motors in W and **n** is the number of powered drive units.

Direct connection to 230V ~ power



Note: The cable connecting the filter and the SLVD must be as short as possible and in no case can it exceed 50 cm.

If the unit is connected directly to the mains, currents on the order of 100A may be required when it is powered on for less than 3 ms. Therefore, protection fuses should be used. If many units are installed in parallel, a sequential power supply procedure is recommended.

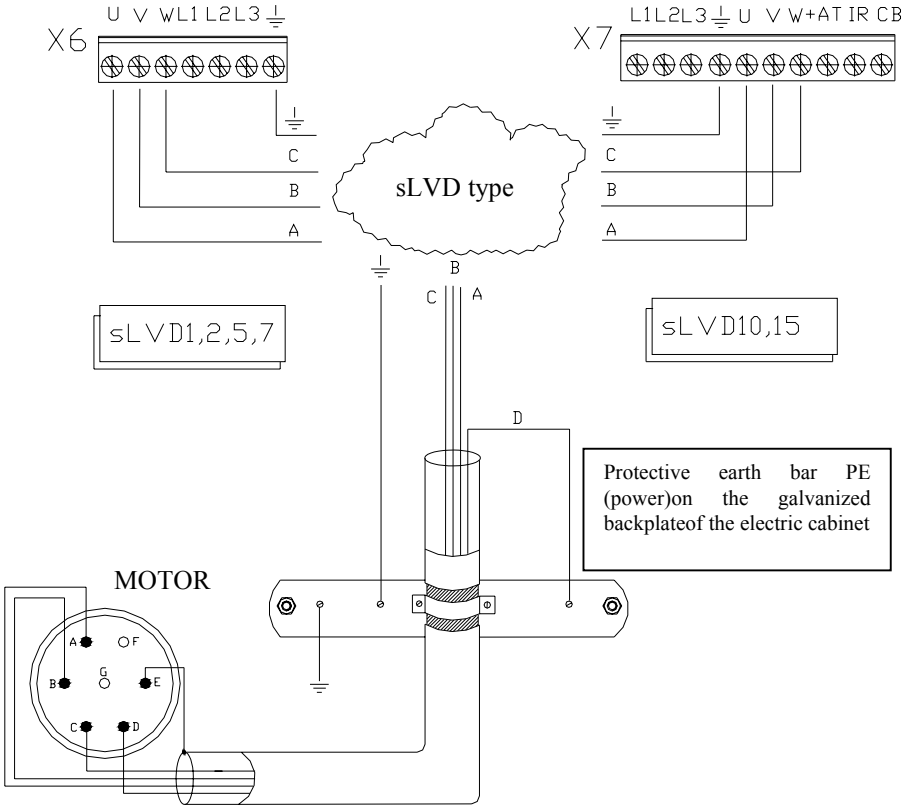
Mono phase connection

If a mono-phase connection is used, a derating of the power supplied by the SLVD converter is obtained. The maximum power supplied by the SLVD with mono-phase power is given by the formula:

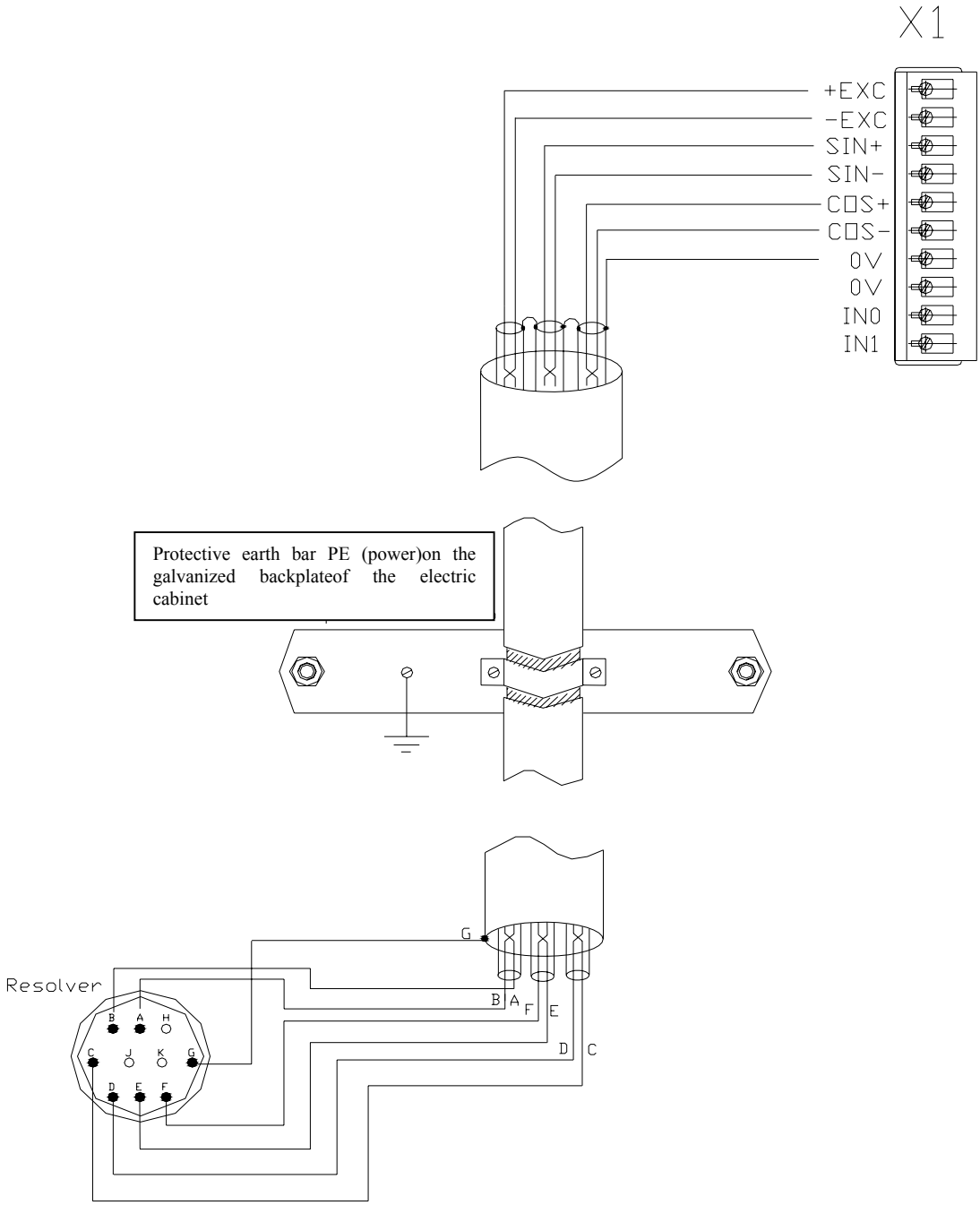
$$\mathbf{Pmax = 27 \cdot 10^{-3}\ Vsupply^2\ [watt].}$$

Where: Pmax= max power out
$27*10^{-3}$ = costant
Vsupply= is a voltage supply

2.6 Motor connection diagrams



2.7 Resolver connection diagrams



2.8 Signal cables connection

The cable used for the analogue reference must be a shielded twisted pair. The cable used to connect the signals of the simulated encoder must consist of three twisted pairs with a general shield. Shielded cables are also recommended for digital inputs and outputs.

All cables must have a minimum section of 0.22 mm^2

2.9 Frequecy input/output connection

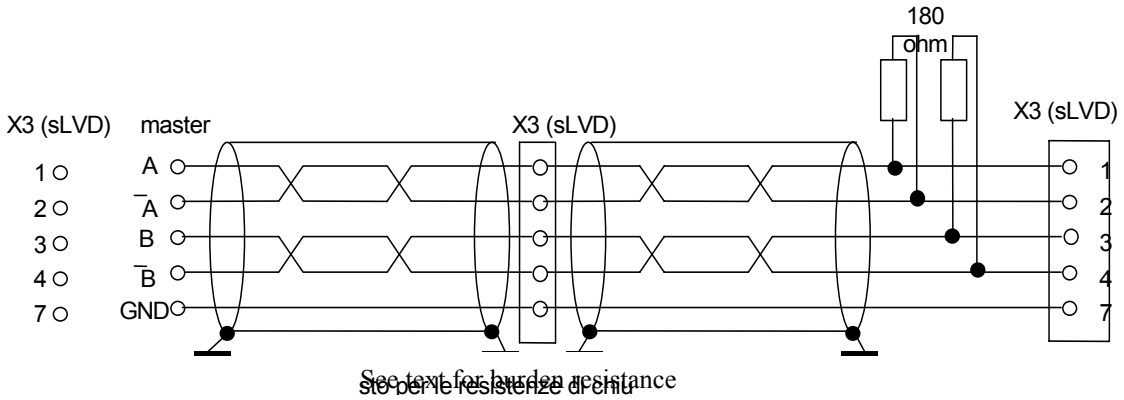
The frequency input/output connector X3 (RS-422) can be configured by the software in different functional modes by using the binary parameters b42.0, b42.1 and b42.5 as given in the table below.

B 42.0	b 42.1	b 42.5	Description of the modes
0	0	1	Incremental encoder simulation. X3 can be programmed in output. The number of pulses/rev. must be programmed in Pr 44.
0	1	1	X3 is programmed as quadrature input (phases A and B). This configuration must be used with operating modes 13 and 14.
0	1	0	X3 is programmed as frequency/sign input. The mode must be set when you want to simulate a stepper motor or the pulses train function.
1	0	1	X3 is programmed as output and the virtual axis function is turned on. (see the section *Additional useful functions*)

N.B. Configurations not given in this table must be avoided.

After the programming, the configuration must be saved and the unit must be powered off and on again.
ATTENTION must be paid when X3 programmed as an input (b42.1=1) is used. Since there is a differential RS-422 connection, it is suitable to connect a closed line resistor of 180 ohm between A/A and B/B. If several input ports are connected in parallel, this operation must be carried out only on the last unit in the chain.

Connecting the SLVD to the digital-lock

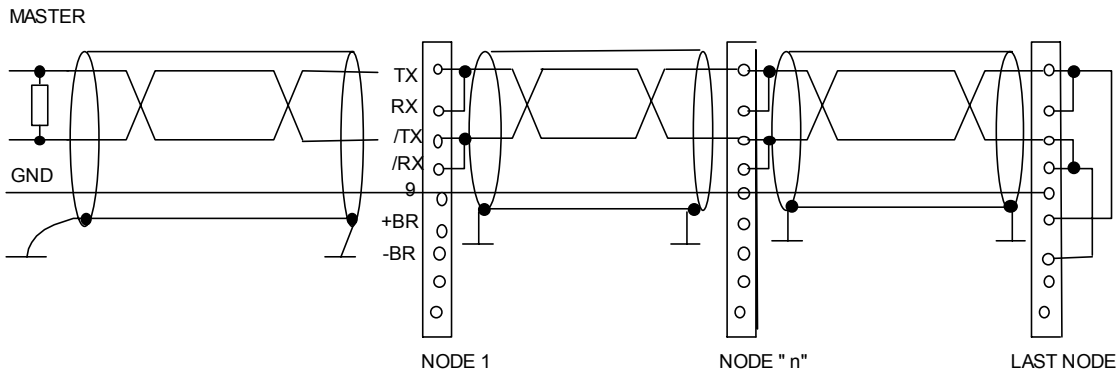


In the example given above, the connection of two sLVD to the Digital-Lock with a master is shown, but the diagram could be extended to several converters respecting the series connection. The line charge resistors must be connected to the last converter. The master can be an encoder powered externally or an encoder simulator of another converter.
The signal of the master encoder must in any case be of differential type 5V RS-422. Therefore, it is possible to connect a maximum of ten slave sLVD.
If the master is a sLVD type converter, you can connect up to 32 converters to the electrical shaft by using the same signal of the simulated encoder (standard RS-422).
To program the sLVD, see the section, *Electrical shaft + positioner*, in this manual.

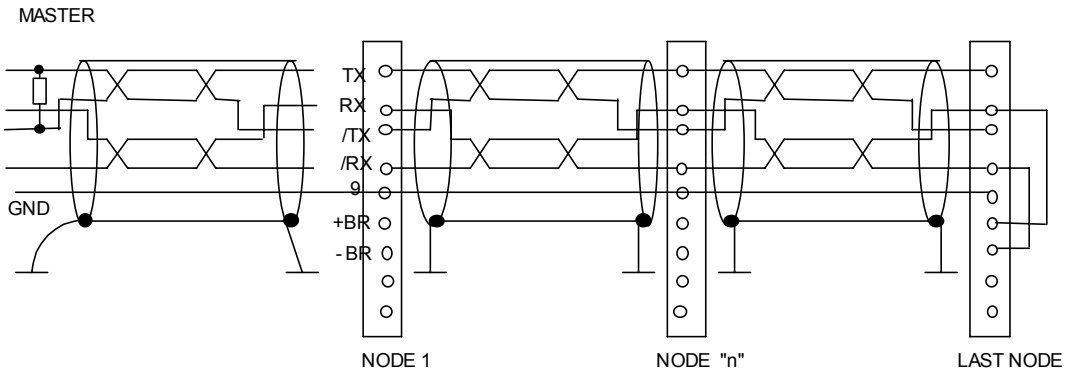
2.10 Serial line connection

The serial line of the SLVD can be configured as either RS-422 or as RS-485 depending on how the connection is made. In both cases you must use termination resistors (150 Ω). If there are several converters connected to the same line, the last node must be terminated as shown in the diagram below. The two configurations are shown in the diagram below.

RS-485

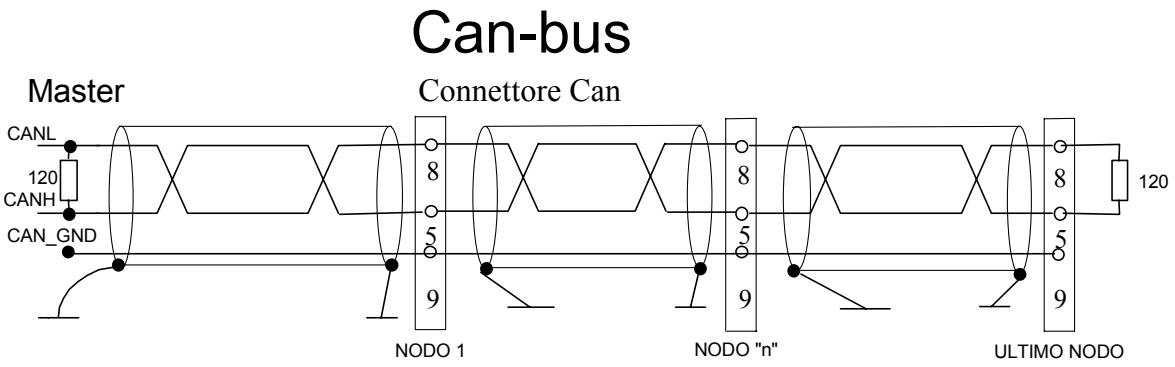


RS-422



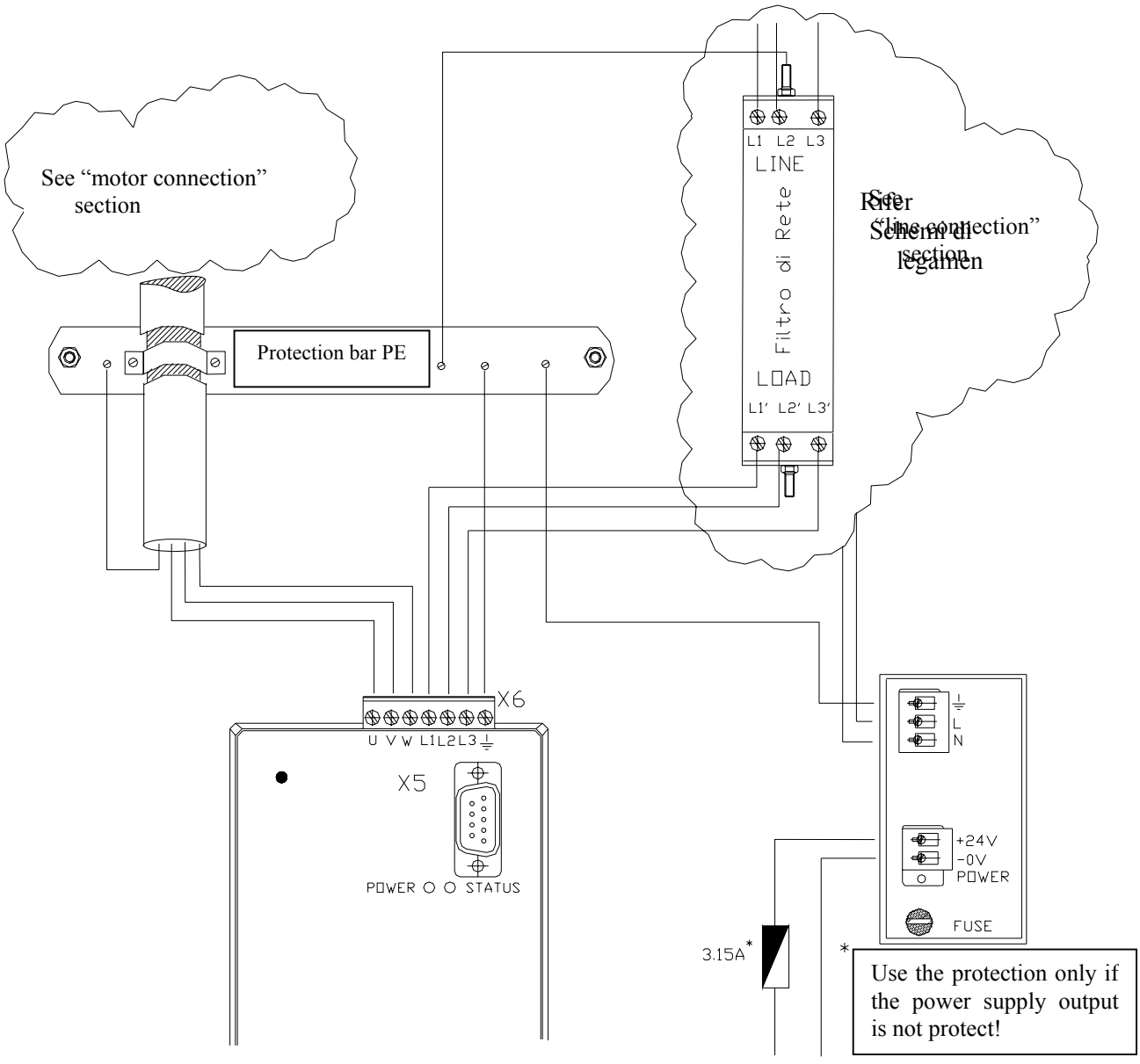
2.11 Can line connection

There is a Can-bus interface on the drive, type Physical layer ISO/DIS11898, the DATA link is full CAN version 2.0 part A (ID 11 bit), and a subset used for application layer SBC Can.



2.12 Cable connections

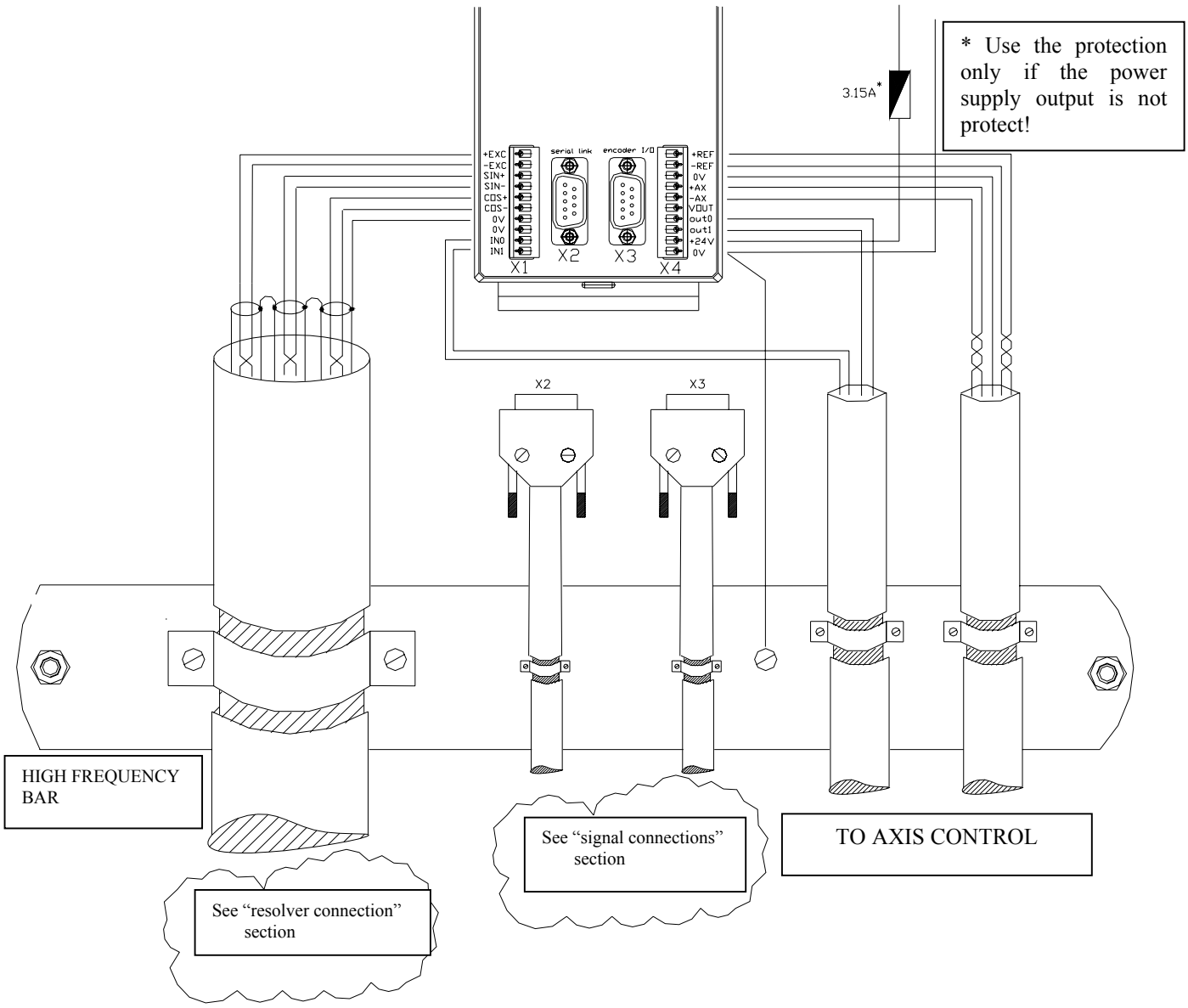
The following pictures show how to realize the cable connections, in particular how to connect the cable shields to the ground bars.



The electrical cabinet back-plate has to be electrically conductive, for example galvanized. Remove optional painting from the back-plate in order to obtain the electrical contact.

The ground bar has to be on electrical cabinet back-plate or a complete electrical connection has to be ensured; the ground bar cannot be isolated.

Divide the routing of the power cables from that of the signal cable. Also the 24DC supply voltage cable has to be shielded.



2.13 Backup

If it is necessary to keep the control electronics of the converter powered up even when there is no current, for example, to keep the encoder simulation operating, it is sufficient to keep power on terminals 9 and 10 of the X4.
If the b99.8 bit is set to 1, when power supply is restored, the undervoltage alarm will be automatically reset.

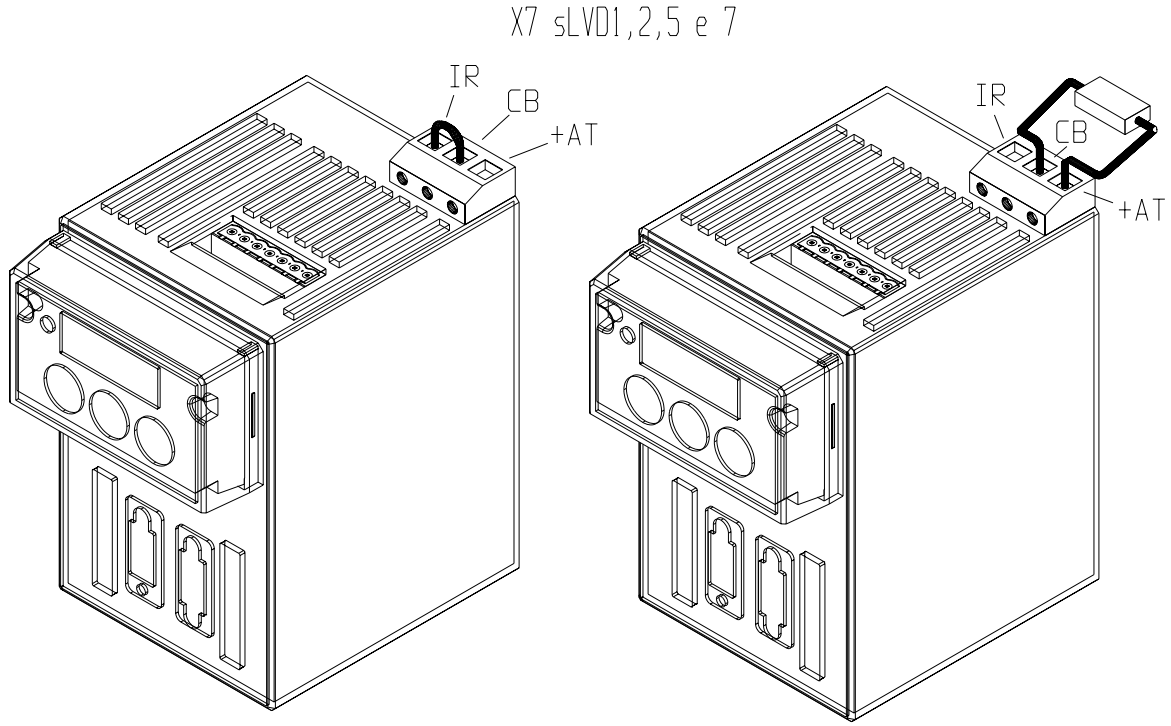
2.14 Status LED

When the programming keyboard is not inserted, two LEDs are lit. The power LED, if on, indicates whether there is power for the electronic part. The status LED gives a series of information about the status of the converter:

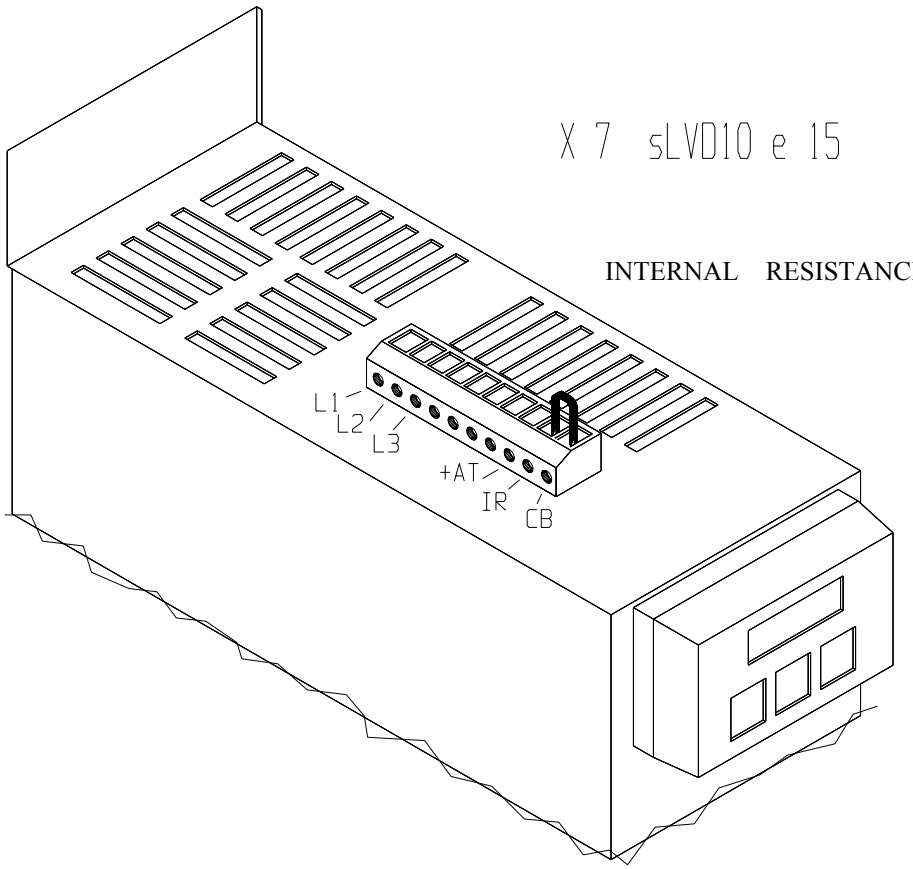
- **If it is off,** the converter is shut off without active alarms.
- **If it is on,** the converter is on.
- **If it blinks quickly** (10 Hz), the converter is powered on. The alarms are not active but the I^2t control is active.
- **If it blinks with a pause after two series of blinks,** the converter is shut off and an alarm is active. The active alarm can be identified by counting the number of blinks between the two pauses.

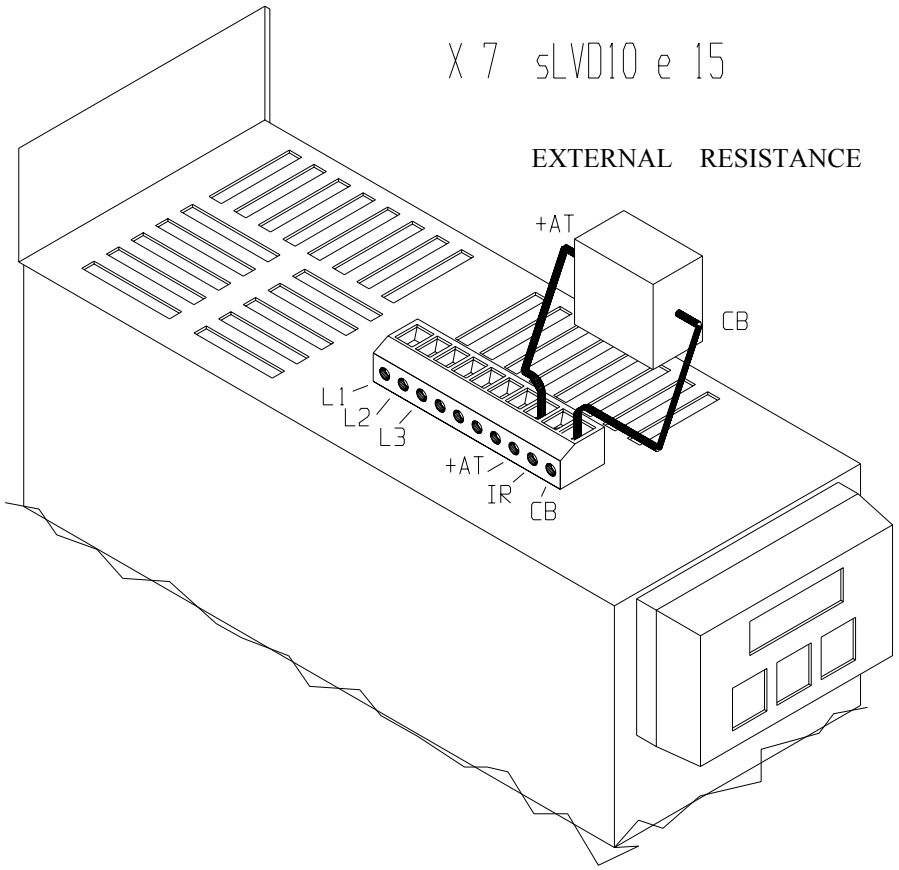
2.15 External braking resistance

The drive has an internal braking resistance. When a higher braking power is needed, it is possible to connect an external braking resistance to the drive.
The possibility to connect an external braking resistance to the drive is optional for sLVD1,2 e 5 (ordering code PR placed at the end of the drive ordering code), while it is standard for sLVD7, 10 e 15.
The external braking resistance value must be 40 Ohm for sLVD 1, 2 5 and 7, for sLVD10 must be 25 Ohm and 16 Ohm for sLVD15, and it is necessary to place a magneto-thermal switch (or a fuse) between the external braking resistance and the drive.
The minimum cross section of the conductors depends on the drive size and it is equal to the minimum cross section of the conductors between motor and drive (see paragraph "Power connections"). It is necessary to minimize the connection cable length. In any case the cable length must be less than 3 m.
The connection of the external braking resistance is shown in the following pictures. The bride between IR and CB terminals (see pictures) enables the internal braking resistance; when the external braking resistance is connected (between CB and +AT terminals), the IR-CB bridge must be removed. It is necessary <u>enable</u> the external braking resistance with the parameter **Pr99.4** to "**1**" and after save the parameter.



INTERNAL RESISTANCE EXTERNAL RESISTANCE


X 7 sLVD10 e 15
INTERNAL RESISTANCE
L1
L2
L3
+AT
IR
CB

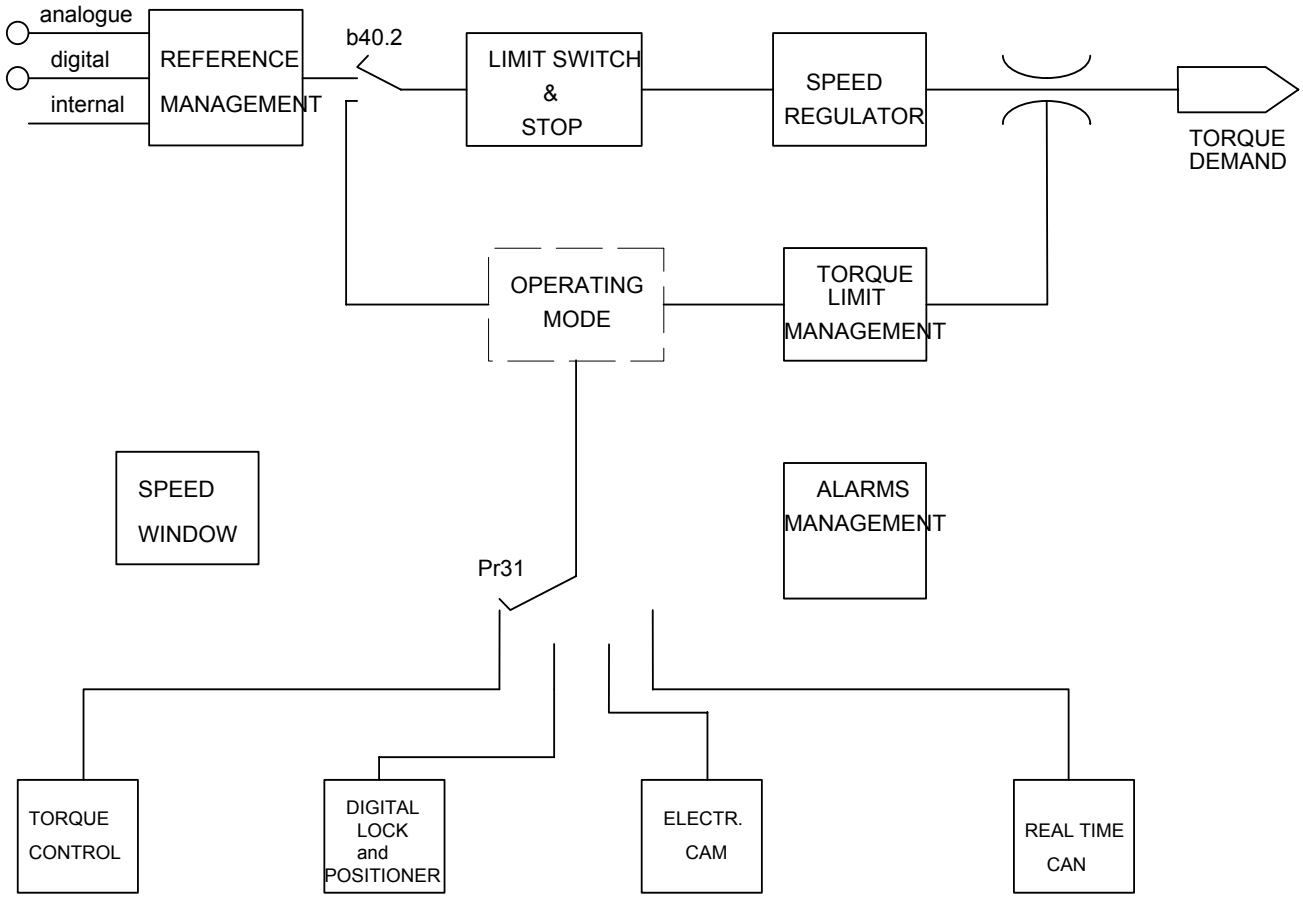

X 7 sLVD10 e 15
EXTERNAL RESISTANCE
+AT
CB
L1
L2
L3
+AT
IR
CB

3 PARAMETERS AND PROGRAMMING

The torque, speed, acceleration and position control functions are carried out by special digital electronics.

In this section we explain how parameters are set and the meaning of each parameter. We also provide the functional block diagram and the description of advanced functions. The system is easy to use and flexible.

In the diagram below the general block diagram of the part of the converter that is controlled by parameters is presented.



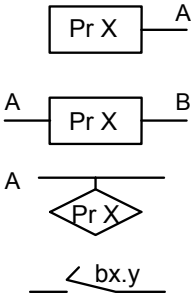
The main block diagram and the diagrams for special functions (operating modes) are described later in more detail.
How to associate inputs/outputs to the parameters of the converter is described in the chapter, *The pico-PLC*.
The parameters are divided on the basis of their function in the following way.

From Pr0 to Pr49	Main parameters
From Pr50 to Pr70	Position loop
From Pr71 to Pr99	pico-PLC parameters
From Pr100 to Pr150	Operating mode parameters
From Pr151 to Pr163	pico-PLC parameters
From In0 to In127	pico-PLC instructions

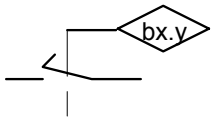
The units of measurement and the main resolutions of the parameters are:

Parameter type	Unit	Resolution
Speed	Revolutions/minute	1
Acceleration	Seconds/1000 revolutions/minute.	0.001
Position	4096 steps/revolution	1/4096 of a revolution
Current	% of the peak current of the converter	0.1

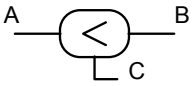
Below we describe how to interpret the symbols used in the block diagrams. The main block diagram describes graphically how the converter works. Each rectangular block represents one or more read-write parameters. The rhomboid blocks represent read-only parameters. You can find other functional blocks in the diagram such as: GREATER THAN, EQUAL TO, LESS THAN, logical AND/OR. For all these functional blocks, standard symbols are used. Binary parameters are represented as switches and the position in the diagram corresponds to the default value.



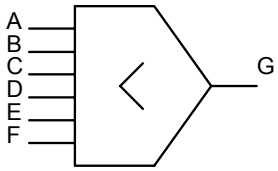
- Read/write of the PrX parameter
  A = value of the PrX parameter
- Read/write of the PrX parameter
  B = value that depends on the values of A and PrX
- Read-only parameter
  PrX indicates the value of A which can also be binary
- Read/write of binary parameter
  The position of the switch indicates bx.y=0



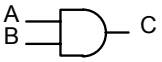
- The value of the binary parameter bx.y positions the switch.



- If A is less than B, C =1 (true). Otherwise, C = 0 (false).

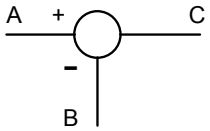


- The value of G is the lowest value of A B C D E F.



- Only if A = 1, B = 1 and C = 1. Otherwise, C = 0.

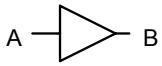
- If A or B is equal to 1, C = 1. Otherwise, C = 0.



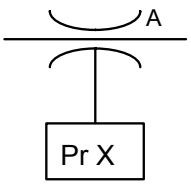
- C = A – B.

- values coming from the hardware

- values sent to the hardware



- the value of A is converted to B. For example, if in the triangle symbol you see A/D, this means that the analogue value of A was converted into the digital value B.

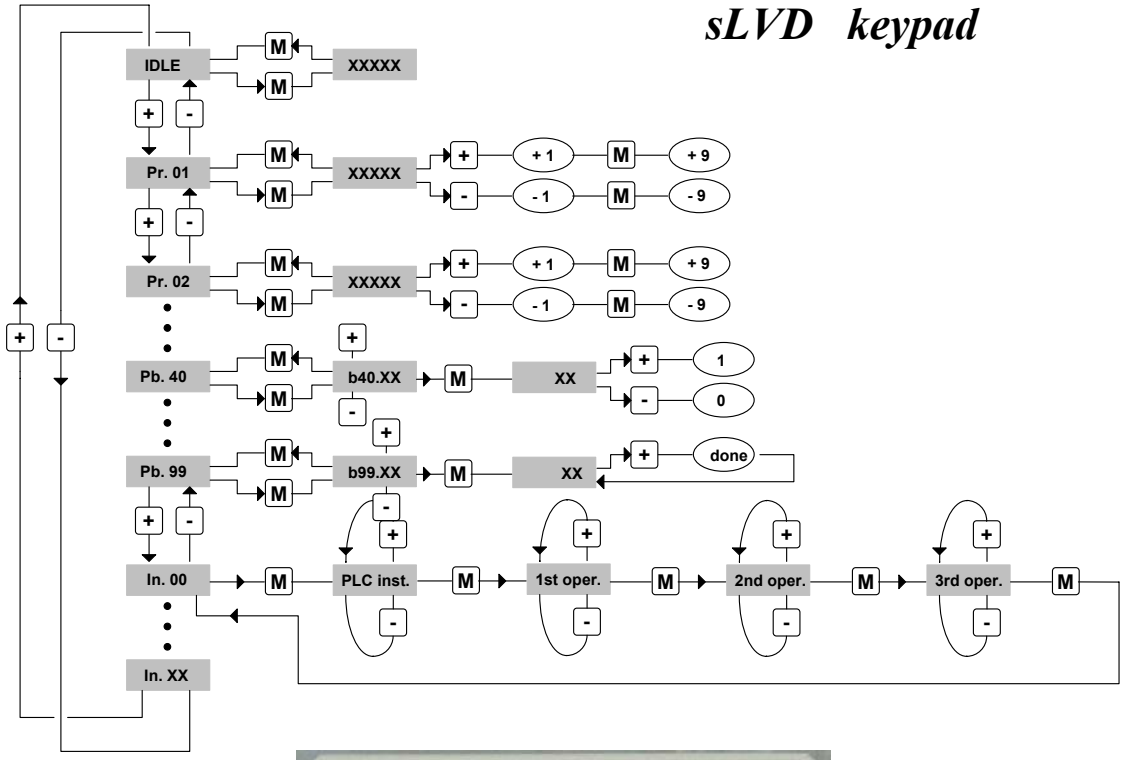


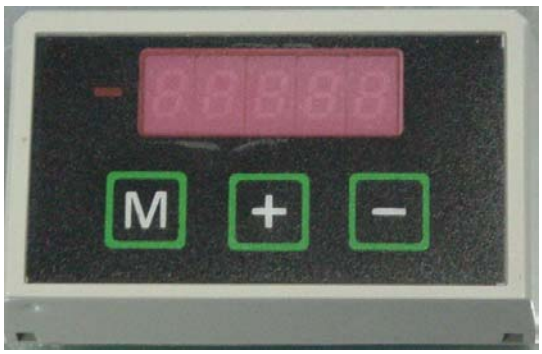
- The maximum value of A will be PrX.

3.1 Using the keyboard (optional)

The keyboard-display module is easy to use. It is used to program the functional data, control the status of the converter and send commands. It consists of only three keys located directly beneath the display. The keys are marked: [M], [+], [-]. The [M] key is use to modify the display and consequently the function of the [+] e [-] keys.
There are two types of display: parameter mode and parameter value mode.
When the converter is powered on, if there is no alarm, the user sees 'IDLE' or 'RUN' on the screen, depending on whether the converter is on or off. This is also the position of the Pr0 parameter.
To view all the parameters, press the [+] o [-] keys. If you want to verify the value, press the [M] key. When the value is displayed, it can be modified by using the [+] e [-] keys. To return to parameter mode, press the [M] key again.
The type of display depends on the type of parameter displayed.
If you need to increment or decrement quickly the value of a parameter, you can do this by pressing the [M] key while the increment [+] key or decrement [-] key is held down.

sLVD keypad





The following messages may be displayed on the screen, in addition to the value of the parameters and the instructions of the pico-PLC:

r. xx When the converter is powered on, this message indicates which version of the software is installed.
IdLE When the converter is powered on and corresponding to Pr0, this message indicates that there is no alarm and that the converter is off.
run When the converter is powered on and corresponding to Pr0, this message indicates that there is no alarm and that the converter is on. The motor shaft may be rotating.
Er. Xx Corresponding to Pr0, this message indicates that the converter has registered an alarm (xx indicates the alarm code) and has shut off. When it registers an alarm, the converter is brought to Pr0, displaying the alarm code.
Pr. Xx Indicates the parameter xx whose value can be displayed by pressing the [M] key.
Pb. Xx Indicates the parameter at bit xx.
bxx.yy Indicates the bit yy of parameter xx. By pressing the [M] key, the status of the bit is displayed.
Hxx.yy Indicates bit yy of parameter 1xx. By pressing the [M] key, the status of the bit is displayed.
In. xx Indicates instruction xx of the PLC program.
donE Is displayed for about 1 second whenever a command is sent.
rESet Is displayed for about 1 second whenever an alarm reset command is sent (b99.10).
dEF Indicates that the drive is set to default status and must be programmed with the basic parameters of the motor.
triP.x Indicates that the converter has malfunctioned.

3.2 Power-on the SLVD for the first time

When the sLVD is powered-on for the first time, or after the 'load default parameters' command is sent, the message **dEF** is displayed to indicate the status of the converter.

At this point the sLVD is waiting for the basic parameters to be set for the motor that is connected. The basic parameters are:

Pr29	Number of motor poles	N
Pr32	Rated speed of the motor	rpm
Pr33	Rated current of the motor	A
Pr34	Number of resolver poles	N
Pr46	Phase-phase motor resistance	ohm
Pr47	Phase-phase motor inductance	mH

After setting the parameters that fit the motor, the operator must give the save data command, b99.15. The drive will calculate the correct values of Pr2, Pr3, Pr16, Pr17, Pr18, and Pr19 and save the parameters. At this point the basic parameters cannot be modified. If you want to modify one of them, you must enter b94.3=1. The "dEF" alarm will be displayed again and after updating the value of the parameter, it must be saved by entering b99.15 again.

3.3 First commissioning of the SLVD

The steps to be followed carefully the first time the converter is used are given below.

1) Connect the motor to the converter by following carefully the diagrams in the manual.
2) Make sure that the converter is shut off (pin 9 of the X1 connector open).
3) Power the converter on.
4) The "IdLE" message will appear on the screen.
5) Set the analogue reference to 0 V (pin 1,2 of the X4 connector) and power the converter on (24 V at pin 9 of the X1 connector).
6) At this point the motor shaft should be stopped. Any change in the voltage of the analogue reference should produce a proportional change in the speed of the motor. If this does not happen, control the cabling.

The converter comes with default values pre-defined that satisfy most applications. In the default status the pico-PLC in the converter runs the program (described in *Appendix*) and the following functions will be set at the input/output connectors:

X1 / inputs	
9	Converter on (24V – on)
10	Stop / Start (24V – Stop)
X4 / outputs	
7	Drive OK (24V – ok)
8	Motor Overloaded (i^2t)

Reduced and extended menu

When the SLVD is in the default status, only a limited number of parameters is displayed. These parameters are the only parameters necessary for those applications where the SLVD is used as a simple converter and where the advanced functions of the converter, for example, if the SLVD is used with a numeric control or with an intelligent axis board, are not used. To switch between the limited menu and the extended menu, enter b99.6: limited menu if equal to 0, extended menu is 1.

The parameters in the limited menu are:

Pr0 Actual speed of the motor shaft in rpm (revolutions per minute).
Pr1 Offset for the main analogue reference.
Pr2 Full scale of the analogue reference: this is the rpm value that corresponds to a reference voltage of 10 V.
Pr8 Value of the acceleration/deceleration ramps in seconds per 1000 rpm, with a resolution of 1 millisecond. If the acceleration/deceleration ramps must be set differently, you must go to the extended menu in order to access the Pr9, Pr10 e Pr11 parameters.
Pr16 Integral gain of the speed regulator.
Pr17 Speed regulator damping.
Pr19 Peak current supplied by the converter, expressed as a percentage of the peak drive rating.
Pr29 Number of poles of the motor.
Pr32 Rated speed (rpm).
Pr33 Rated current supplied by the converter (which can be maintained indefinitely) expressed as rated current of the motor (A).
Pr35 Instantaneous current required by the motor expressed as a percentage of the peak drive rating.
Pb99 Bit parameter for the basic commands.

The extended menu offers access to all the parameters and instructions of the pico-PLC, in addition to those specified above.

Setting the default parameters

If you want to set the default values of the converter as it was supplied by the manufacturer, do the following:

- power off the converter using the hardware (pin 9 of X1 open)
- power the converter on
- the IdLE message appears on the screen
- set b99.7 and b99.13 to 0
- issue the command b99.12
- save the set up using commands b99.14 and b99.15.

3.4 Main parameters

The extended menu is used to set all the following parameters. This menu is invoked by setting b99.6 to 1 and b99.7 must be set to 0.

DECIMAL PARAMETERS

Pr0 **Motor speed**: a read-only parameter expressed in rpm; the Pr0 message is not ever displayed on the screen. Instead, the message indicating the status of the converter is displayed.

Pr1 **Analogue reference offset**. Expressed as a count of the input converter. The limits are –8000 and +8000.

Pr2 **First full scale of analogue reference**: Unit = rpm, range=±10000, default=3000. If b40.0=0 and b40.12=0, the value of Pr7 will be equal to:
Vin · Pr2 / 9.76 where Vin is the voltage at the analogue input.

Pr3 **Second full scale of the analogue reference:** Unit = rpm, range=±10000, default=3000. If b40.0=0 and b40.12=0, the value of Pr7 will be equal to:
Vin · Pr2 / 9.76 where Vin is the voltage at the analogue input.
If b42.0=1, b42.1=0, and b42.5=1, Pr3 is the speed of the virtual axis.

Pr4 **Full scale of frequency reference:** (connector X3). Unit = rpm, range=±32767, default=3000. If b40.12=1 and b40.13=1, the value of Pr7 will be the following:
If b42.5=0, Pr7 = Fin · Pr4 *2 / 2000000 (frequency/sign signals)
If b42.5=1, Pr7 = Fin · Pr4 *2 / 500000 (quadrature signals)
where Fin is the frequency present at the encoder input:
Fin=enc speed [Rpm] * enc pulses turn / 60

Pr5 **Internal reference**: Unit = rpm, range=±9000, default=0. If b40.12=1 and b40.13=0, Pr7 will be equal to Pr5.

Pr6 **Reserved speed reference (read-only):** Unit = rpm, range=±9000. If b40.2=1, this value is used as a reference for the speed regulator. The active operating mode will write its speed request in parameter Pr6.

Pr7 **Main reference (read-only):** Unit = rpm, range=±9000. If b40.2=0 is used, Pr7 is the reference for the speed regulator. In some operating modes Pr7 can be used as a reference for other values (torque/acceleration) and in these cases Pr7 will be expressed in the most suitable unit of measurement.

Pr8 **Acceleration ramp for positive speed:** Unit = s/krpm, range=0.002...65.535, resolution=0.001 s, default=0.002 s. Positive speed acceleration required by the motor via the speed reference is internally limited so that to achieve an acceleration of 1000 rpm, Pr8 seconds are necessary.

Pr9 **Deceleration ramp for positive speed:** Unit = s/krpm, range=0.002...65.535, resolution=0.001 s, default=0.002 s. Positive speed deceleration required by the motor via the speed reference is internally limited so that to achieve an acceleration of 1000 rpm, Pr8 seconds are necessary.

Pr10 **Acceleration ramp for negative speed:** Unit = s/krpm, range=0.002...65.535, resolution=0.001 s, default=0.002 s. Negative speed acceleration required by the motor via the speed reference is internally limited so that to achieve an acceleration of 1000 rpm, Pr10 seconds are necessary.

Pr11 **Deceleration ramp for negative speed:** Unit = s/krpm, range=0.002...65.535, resolution=0.001 s, default=0.002 s. Positive speed deceleration required by the motor via the speed reference is internally limited so that to achieve an acceleration of 1000 rpm, Pr11 seconds are necessary.

Pr12 **Deceleration ramp for limit switch and stop functions:** Unit = s/krpm, range=0.002...65.535, resolution=0.001 s, default=0.002 s. Deceleration required by the motor for limit switch and stop functions is internally limited so that to achieve an acceleration of 1000 rpm, Pr12 seconds are necessary.

Pr13 **Overspeed limit:** Unit = rpm, range=0..+13000, default=3500. If the absolute value of the motor speed exceeds the value set in Pr13, b41.0 will be =1, Otherwise, it will be = 0.

Pr14 **High speed limit:** Unit = rpm, range = ±13000, default=20. If b40.7=0 and if the difference of the speed of the motor and the reference is less than Pr14 and greater than Pr15, b41.1 will be = 1. Otherwise, it will be 0. If b40.7 = 1 and if the motor speed is less than Pr14 and greater than Pr15, b41.1 will be =1. Otherwise, it will be =0.

Pr15 **Low speed limit:** Unit = rpm, range = ±13000, default=-20. If b40.7=0 and if the difference of the speed of the motor and the reference is less than Pr14 and greater than Pr15, b41.1 will be =1. Otherwise, it will be =0. If b40.7=1 and if the motor speed is less than Pr14 and greater than Pr15, b41.1 will be =1. Otherwise, it will be =0.

Pr16 **Integral gain of the speed regulator:** Range=0...32767, default = N.A.

Pr17 **Damping of the speed regulator:** Range =0...32767, default = N.A. If Pr16=0, Pr17 is the proportional gain of the speed regulator.

Pr18 **Band width limiter:** Unit =128μs, range=1..1000, default = N.A. Pr18 is used to set the time constant of a first order filter placed on the digital signal of the torque request. The frequency of the filter cut will be: 1240/Pr18 Hertz.

Pr19 **Peak current:** Unit =%, range=0...100.0%, resolution=0.1%, default = N.A. This is the maximum current that the converter can supply to the motor. It is expressed as a percentage of the peak current of the converter. In general, it should never exceed three times the rated current of the motor.

Pr20 **DC bus voltage:** Unit =volt, read-only parameter. Displays the value of the voltage present on the DC bus.

Pr21 **Torque limiter (read-only):** Unit = %. Can be used by the operating modes to limit the torque to the motor.

Pr22 **Auxiliary analogue reference:** Unit = %. The value displayed will be Pr22=Vin·100/9.76. The resolution is of 0.2%.

Pr23 **Alarm code:** This is the code for the alarm that is present. Code 0 represents the absence of alarms. Consult the table of alarm codes for more details.

Pr24 **Latest alarm:** This parameter contains the latest alarm. Pr24 will be set to 0 during the execution of the alarm reset command (b99.10).

Pr25 **Software version code (read-only):** Indicates the version of the software that has been installed.

Pr26 **Serial line speed code:** Default=5. This is the code for programming the transmission speed. For more information, consult the section on the serial interface.

Pr27 **Serial line address code:** Default=0, range =0..31. For more information, consult the relevant section.

Pr28 **Motor shaft position (read-only):** Unit = steps, range=0...4095. Indicates the absolute position of the resolver.

Pr29 **Number of motor poles:** Range =2..64, default = N.A.

Pr30 **Offset of the resolver position:** Default=0. Used to correct electronically the mechanical position of the resolver.

Pr31 **Operating mode:** Default=0. Used to select the active operating mode. The value 0 means that no operating mode has been selected.

Pr32 **Rated speed:** Unit = rpm, range=0...9000, default = N.A. This is the rated speed of the motor. The speed that has been set is used to limit the speed request. Therefore, it should be set to about 10% greater than the maximum operational speed.

Pr33 **Rated current of the motor:** Unit=range=0.5...5.0A, resolution =0.1A, default = N.A. The rated current of the motor must be set.

Pr34 **Number of poles on the resolver:** range = 2, 4, 8; default = N.A.

Pr35 **Torque monitor:** Unit = % of the torque at peak current, resolution 0.1%. Indicates the percentage of the torque or of the current that the motor is supplying.

Pr36 **Thermal image winding (read-only):** Unit = % of the rated temperature. Indicates the estimate of the heat in the innermost coils of the motor. If this reaches the value of 100.0 % equal to the nominal value, b41.11 will become 1 and therefore the current will be limited to the nominal value.
Description: if the drive generate the max current, starting from 0 current, after 2s, Pr36=100% and Pb41.11=1 result: the drive limits the current at the rated current. This situation remains untill the dirve generates "0" current and after 35s Pr36 is "0" again.

Pr37 **Thermal image of the braking resistor (read-only):** Unit = % of the rated temperature. Indicates the estimate of the heat of the braking resistor. If the value reaches 120.0 %, the converter issues an alarm.

Pr38 **Auxiliary analogue output:** Unit =% of 4.5V, default=0, range =±100.0%, resolution 8 bit. If b40.11 = 1, the auxiliary analogue output will be equal to 450·Pr38/100 volts.

Pr43 **Zero encoder offset**. Range 0...4095, default=0. This parameter is used to modify the position of the output zero trace for the zero resolver (Pr28).

Pr44 **Number of pulses per revolution**: Range 4...8000, default=1024. This is the number of pulses per revolution that is used by the simulation encoder. The maximum frequency is 120 kHz.

Pr45 **Main analogue input:** Unit=8000esimi of 9.76V, range =±8192. Represents the value of the main analogue input.

Pr46 **Motor resistance:** Unit ohm. The phase-phase resistance of the motor.

Pr47 **Motor inductance:** Unit Mh. The phase-phase inductance of the motor.

Pr48 **Can bus speed code:** Default=0, see the section *CANBUS*.

Pr49 **Can Open Address.** The addresss range is from 1 to 127. Default: "0"

BINARY PARAMETERS

The binary parameter Pb40 can be read and set and then stored. The binary parameter Pb41 provides indications about the status of the system. The parameters Pb42 and Pb99 be read and set and then stored.

B40.0 **Selection of the first or second full scale of the speed reference:** Default value=0. If = 0, Pr2 will be used to rate the analogue reference. If = 1, parameter Pr3 will be used.

B40.1 **Activation of the algorithm to suppress vibration at 0 speed:** Default=0. If = 1, the algorithm is turned on.

B40.2 **Selection of the reserved/user reference:** If = 1, the reserved reference of the operating mode in use is used. If = 0, the reference selected by b40.0, b40.12 and b40.13 is used. Default = 0.

B40.3 **Reference hold:** Default=0. If = 1, the reference will not be updated and the motor will not follow the variations of the input reference. If = 0, the reference will follow the variation of the input reference.

B40.4 **Left limit switch:** Default=0. If = 1 and the reference selected requires negative speed, the reference is set to 0 following the ramp set in Pr12. If = 0, no control is made.

B40.5 **Right limit switch:** Default=0. If = 1 and the reference selected requires negative speed, the reference is set to 0 following the ramp set in Pr12. If = 0, no control is made

b40.6 **Stop function:** Default=0. If = 1, the motor is set to zero speed following the ramp set in Pr12.

B40.7 **Selection of the absolute/relative speed window:** Default=0. If = 0, the speed window Pr14 Pr15 b41.1 will function in relative mode. Otherwise, if = 1, it will function in absolute mode.

B40.8 **Analogue torque limit:** Default=0. If = 1, Pr22 will be used and also the auxiliary analogue input in order to limit the torque to the motor. The sign of voltage at aux. differential analog input doesn't interest.

B40.9 **Software enable:**. Default=1. If = 0, the converter cannot be enabled.

B40.10 Reserved.

B40.11 **Selector for auxiliary analogue output:** Default=0. If = 0, a signal proportional to the torque (b42.4=1) or to the speed (b42.4=0) supplied by the motor will be present at the auxiliary analogue output. If = 1, a value proportional to Pr38 will be present.

B40.12 **Selection of the digital/analogue reference:** Default=0. If = 0, the analogue input will be selected as the main reference. If = 1, the reference will be digital and b40.13 can be used to select parameter Pr4 or parameter Pr5.

B40.13 **Selector of internal reference Pr5 or frequency reference Pr4:** Default=0. If b40.12 = 1, b40.13 can be used to make the selection. If = 0, the internal reference can be used. If = 1, the frequency input (encoder-in) which can be configured as frequency/direction or as a quadrature signal by using b42.5.

b40.15 Reserved.

B41.0 **Overspeed:** When the absolute value of the motor speed exceeds the value set in Pr13, b41.0 = 1. Otherwise, b41.0 = 0.

B41.1 **In speed:** If b40.7 = 0 and if the difference in speed between the motor and the reference is less than Pr14 and greater than Pr15, b41.1 = 1. Otherwise, = 0. If b40.7=1 and if the motor speed is less than Pr14 and greater than Pr15, b41.1 =1. Otherwise, = 0.

B41.2 **Zero speed:** If the motor speed (Pr0) = 0, b41.2=1. Otherwise, b41.2 = 0.

B41.3 **Forward:**. If the motor speed (Pr0) is positive, b41.3 = 1. Otherwise, b41.3 = 0.

B41.4 **Converter O.K**.: If = 1, there is no alarm. Otherwise, = 0.

B41.5 **Status of hardware enable:** When hardware enable is present, = 1.

B41.7 **External alarm:** An alarm that can be used by the user.

B41.8 **Auxiliary alarm**. A second alarm that can be used by the user.

B41.9 **CanBus watchdog:** This bit is set to 1 at every block sync reception via SBCCAN.

B41.10 **Saturation of the speed regulator:** b41.10=1 when the speed regulator is supplying the maximum current.

B41.11 **I^2T active:**. Indicates that Pr36 has reached the 100.0 % value and therefore the converter is limiting the current to the nominal value.

B41.12 **Converter enabled**.

B41.13 **Bus warning**: Indicates a momentary communication error on the SBCCAN.

B41.14 **Bus off error:** Indicates a permanent communication error on the SBCCAN.

B41.15 **CanBus watchdog:** This bit is set to 1 at every sync (0 or 1) reception via SBCCAN.

B42.0 **Virtual encoder enabled:** Default=0; 1= function enabled. See the section, *Other useful functions*.

B42.1 **Encoder port direction** (X3 connector). Default=0; 0=output, 1=input.

B42.2 **Torque control:** Default=0. If set to 1, the main analogue reference is assumed as the reference for the torque control (torque servocontrolled mode).

B42.4 **Selector to configure analogue output:** Default=0. If set to 0, the analogue output represents the instantaneous speed of the motor, 4.27V at Pr32 speed. If set to 1, it represents the instantaneous torque, 4.5V at the peek current of the drive. The selector is valid only if b40.11 = 0.

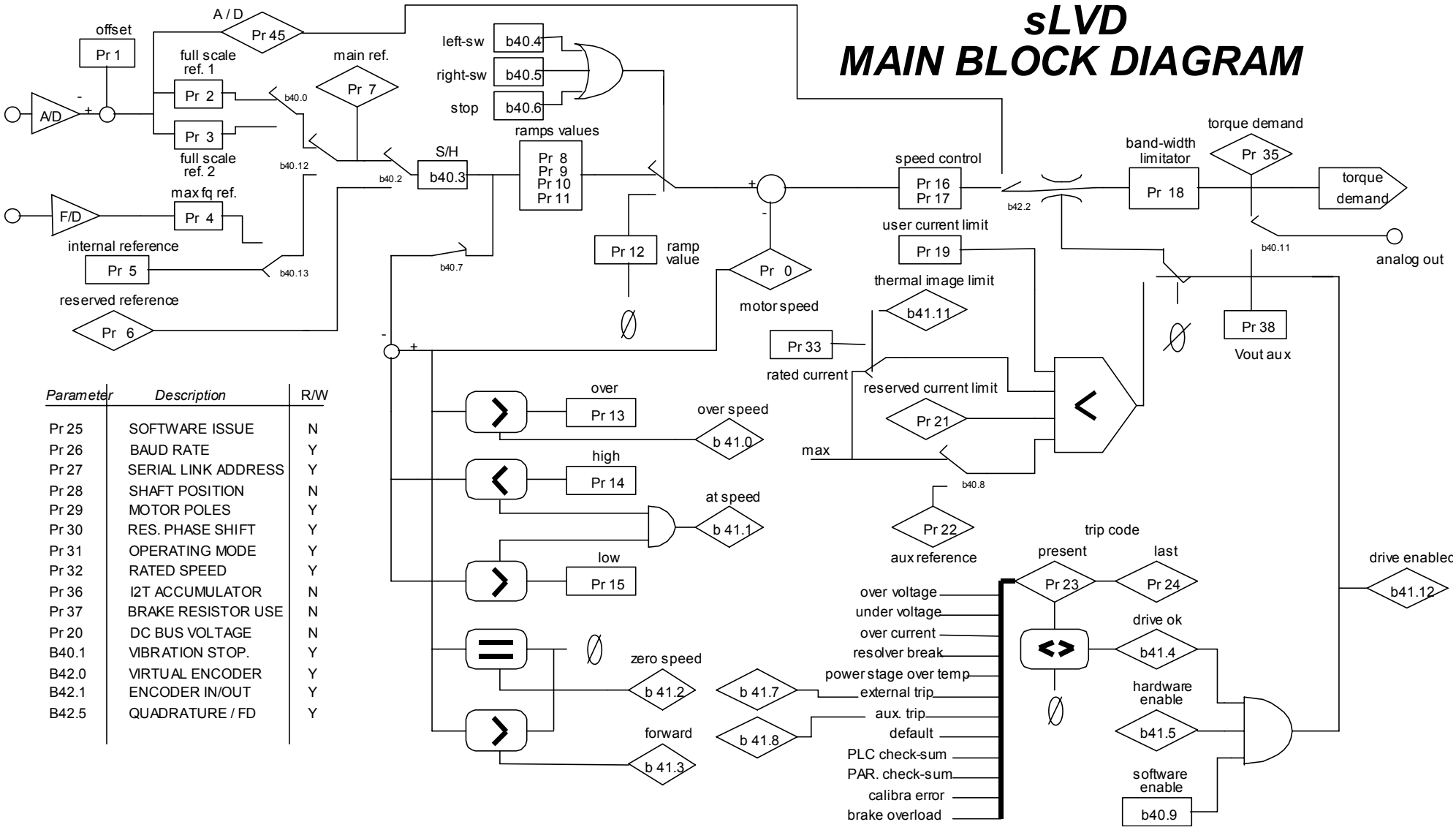
B42.5 **Frequency input (X3 connector):** If set to 1, the frequency input is programmed to receive two quadrature phases and this is the default value. If set to 0, a frequency/direction type of input can be received.

B42.6 e B42.7 **Selection the type of feedback.** Is possible choose between resolver and encoder.

B94.3 **Basic parameters keylock.** If set to 1, it is possible to modify the basic parameters (see the section *Power-on the SLVD for the first time*).

B99.4 **Enable the external braking resistance.** Default =0. If =1 the external braking resistance is enable (see the section)
B99.6 **Extended menu enable:** Default=0. If set to 1, the extended menu is enabled.
B99.7 **Safety:** Default=0. If set to 1, parameters cannot be modified.
B99.8 **UV auto reset:** Default=0. If set to 1, the under-voltage alarm will automatically be set to 0 when power returns.
B99.13 **Status of the pico-PLC:** Default = 1. If set to 1, the PLC program is executed. If set to 0, the pico-PLC is in stop and the PLC instructions can be modified.

sLVD
MAIN BLOCK DIAGRAM



Parameter	*Description*	R/W
Pr 25	SOFTWARE ISSUE	N
Pr 26	BAUD RATE	Y
Pr 27	SERIAL LINK ADDRESS	Y
Pr 28	SHAFT POSITION	N
Pr 29	MOTOR POLES	Y
Pr 30	RES. PHASE SHIFT	Y
Pr 31	OPERATING MODE	Y
Pr 32	RATED SPEED	Y
Pr 36	I2T ACCUMULATOR	N
Pr 37	BRAKE RESISTOR USE	N
Pr 20	DC BUS VOLTAGE	N
B40.1	VIBRATION STOP.	Y
B42.0	VIRTUAL ENCODER	Y
B42.1	ENCODER IN/OUT	Y
B42.5	QUADRATURE / FD	Y

3.5 Basic commands

In order to send the following commands, b99.7 must be set to 0. To send the b42.3 and b94.1 commands, b99.6 must also be set to 0.

B42.3 **Reinitializing the serial line and the SBCCAN.** Command to initialise serial communication whenever the speed value of the serial line (Pr26) has been modified. Command to initialise the SBCCAN whenever the address or the function mode has been modified. The serial line and the SBCCAN are in any case initialise when the converter is powered on.

B94.1 **Command to set the main reference offset to 0.** This command is used to automatically set the Pr1 parameter in order to automatically set the voltage offset on the main analogue reference to 0. This operation can be done only if the absolute value of the offset is less than 200 Mv.

B94.8 **Value comparator.** See the section, *Other useful functions*.

B94.9 **Value comparator.** See the section, *Other useful functions*.

B94.10 **Value comparator.** See the section, *Other useful functions*.

B94.11 **Value comparator.** See the section, *Other useful functions*.

B99.10 **Command to reset alarms.** This command sets Pr23 and Pr24 to 0. If the alarm continues, it is displayed on the screen. This command cannot be used if there is a check-sum error (Pr23 = 10, 11). In this case, it is necessary to set the default parameters (b99.12) and then reset the alarm.

B99.11 **Default values of the parameters in operating mode**. This command sets the operating mode parameters to the default values. The command is executed only if b40.2 = 0.

B99.12 **Default values.** This command sets all parameters to the default values and sets those used by the operating mode to 0. Furthermore, it sets the pico-PLC program as described in *Appendix F*. There is a check-sum alarm, Pr23 and Pr24 will be set to 0, thereby permitting the alarm to be reset. The command is executed only if b99.13 = 0.

B99.14 **Storing of the pico-PLC instructions.** This command saves the pico-PLC program. It cannot be used if a check-sum alarm has been indicated. In this case, it is necessary to set the default parameters, reset the alarm and then store the new parameters.

B99.15 **Storing of parameters.** This command stores all parameters. It cannot be used if a check-sum alarm has been indicated. In this case, it is necessary to set the default parameters, reset the alarm and then store the new parameters.

3.6 Speed control adjustment

SOME IMPORTANT CONCEPTS

SPEED LOOP: The main task of a converter is to control motor speed so that it follows as faithfully as possible the speed request that is generally known as the REFERENCE.

Faithfully following the reference means that the motor speed should equal the reference in static conditions and also that the motor speed is as equal as possible to the speed requested during dynamic conditions. To carry out this task, the converter must know some of the features of the motor used and the mechanical part attached to it. This information is communicated to the converter by using the so-called ADJUSTMENT PARAMETERS.

ERROR: The error is the difference between the reference speed and the motor speed. The size of the error is used by the speed loop in order to evaluate how much current must be supplied to the motor, based on the adjustment parameters.

TORQUE: The current that circulates in the windings of the motor is transformed in torque, thereby allowing the motor to accelerate or decelerate.

GAIN: Given the typical applications of the sLVD converter, when we speak of gain in this document we refer to the rigidity of the axis, better known as the STIFFNESS.

To better illustrate what stiffness means, we can imagine a motor controlled by a converter with a requested speed of 0. The motor shaft will appear immobile, but if we apply a torque to the shaft, it will demonstrate an angle that is proportional to the torque applied. Suppose we apply the rated torque of the motor and measure the stiffness in degrees. The measured degrees will be the index of the regulator tuning quality. Clearly, it is not the only quality index.

WHAT IS NEEDED

To adjust a sLVD converter correctly, an oscilloscope with memory must be used. A technician who can use it to carry out the operation will also be needed. If it is not possible to use an oscilloscope, a more approximate but applicable adjustment method will be illustrated at the end of this section.

BEFORE BEGINNING

Study the diagram below carefully (Fig. 1):

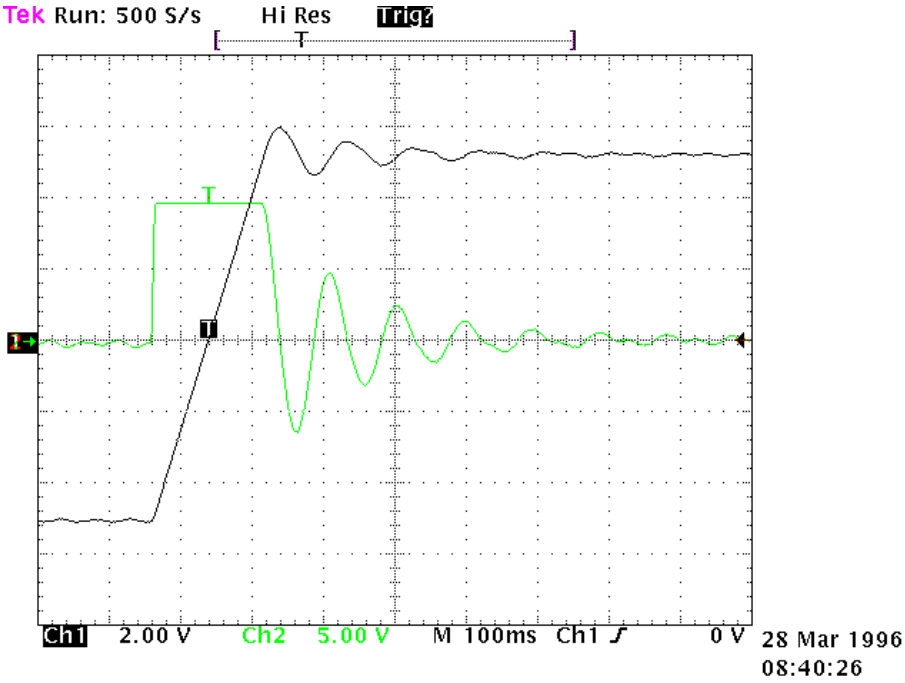


Fig. 1

This diagram shows the response of the system to a square wave speed reference. Channel 1 (Ch1) represents the speed and channel 2 (Ch2) the current of the motor. In practice, the probe has been connected to terminal 6 of the X4 (Vout). The two traces cannot be seen at the same time, but the trace to be displayed can be programmed using the binary parameter Pb42.4. The V/div scale and the time basis will not be discussed here since they can vary greatly.

ESTIMATING THE Pr16

Before turning the converter on, the user should estimate the value of Pr16. The value of Pr16 is what defines the gain of the system. To convert the value of Pr16 into grades per rated torque, the formula to be used is the following: $\alpha = \frac{Pr33*100}{Pr16*Ipd} \cdot 28$ where α represents the stiffness and Ipd is the peak current of the drive. Before using the formula, Pr33 must be set with the correct value of the rated current of the motor. To evaluate the correct value of α, let's consider that, if the mechanical part to be moved is rigid (non-elastic) and if there is no transmission play, the optimal stiffness would be about 4 degrees. If the mechanical part is not rigid enough, it could be necessary to reduce the gain. If the torque of the motor has been sized in order to obtain strong acceleration, but during the operation, the disturbing torques are very low, it is possible to choose stiffness angles of 20, 30 or 40 degrees, thereby maintaining acceptable performance. If it is difficult to choose the proper stiffness angle, the user can begin with 10 degrees that is the default adjustment if a motor with the same rated current as the converter's is used.

At this point, let us set the Pr16 to the estimate and turn on the axis with a square wave reference. The user must be careful to choose reference ranges and frequencies in order to avoid problems if the axis has a limited course. By observing the oscilloscope we will note that as Pr17 varies, the response will change. For decreasing values of Pr17, the response of the system will be as shown in figure 2 below:

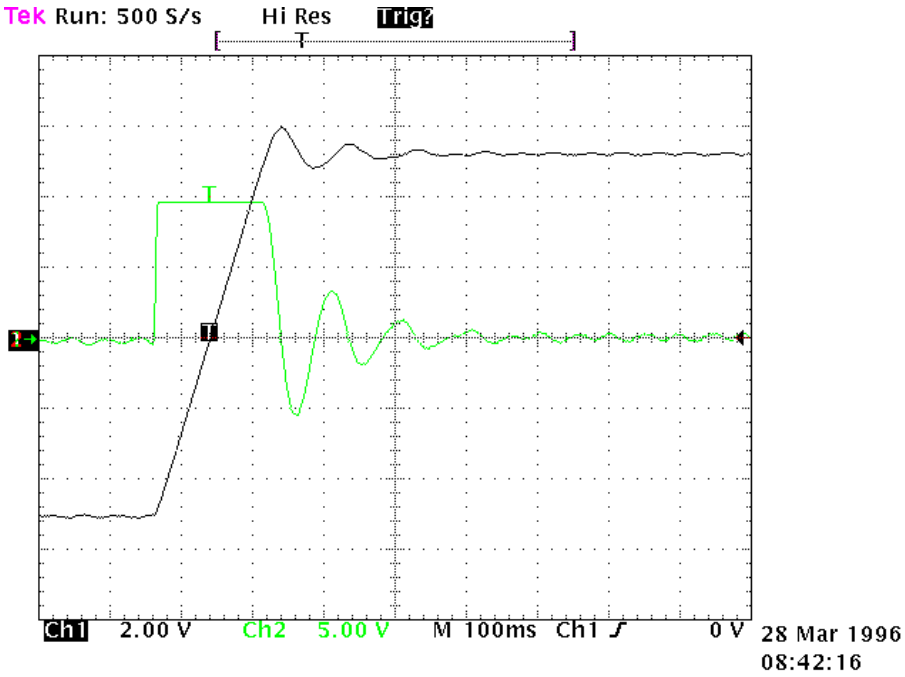


Fig.2

For increasing values of Pr17, the response of the system will be similar to what is shown in figure 3 below:

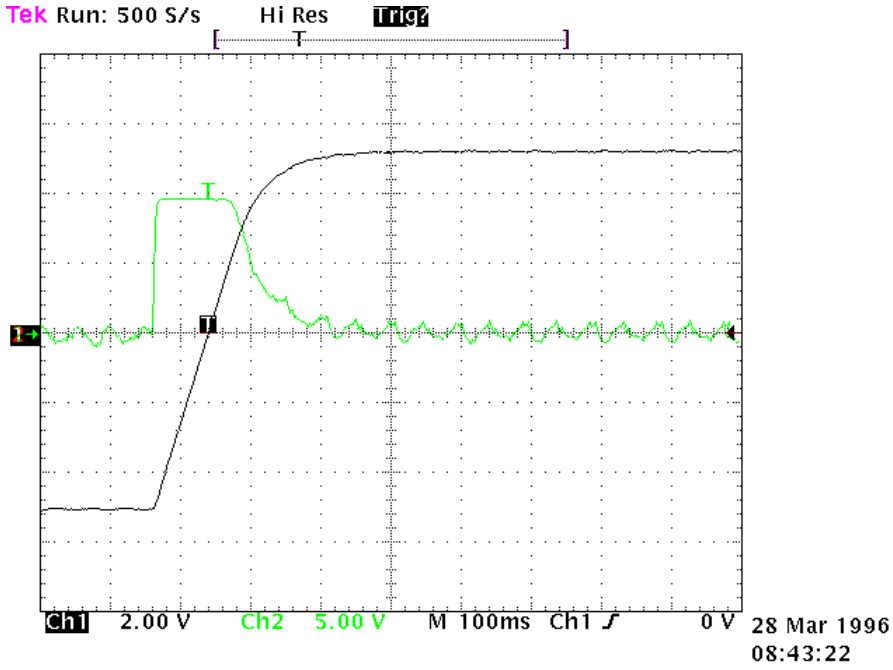


Fig.3

The optimal value of Pr17 will be attained with a response of the system as shown in figure 4 below:

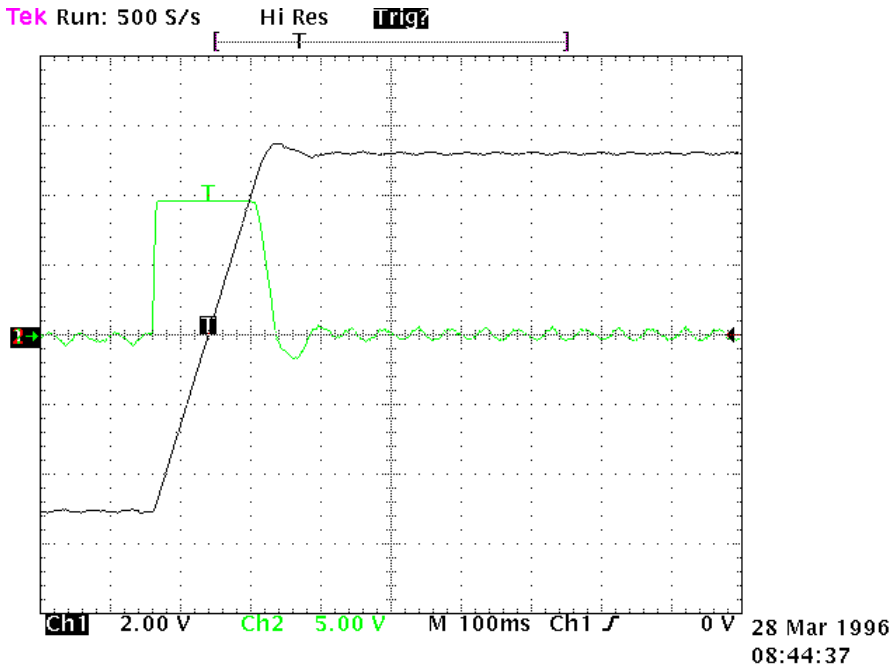


Fig. 4

An overshoot of about 10% must be obtained. It is important that after the overshoot, an undershoot does not occur.

Once the optimal value of Pr17 has been established, we must analyze the movement of the axis. If it moves without vibrations and acoustic noise, the adjustment of the system is complete. Otherwise, we must repeat the preceding procedures with lower values of Pr16.

In some applications it is possible to reduce acoustic noise by using a higher value of Pr18. Figure 5 shows that once the optimal adjustment has been achieved, there is also an oscillation of the current that can produce acoustic noise and mechanical vibration. By raising the value of Pr18 to 3, the situation is much improved (fig. 6).

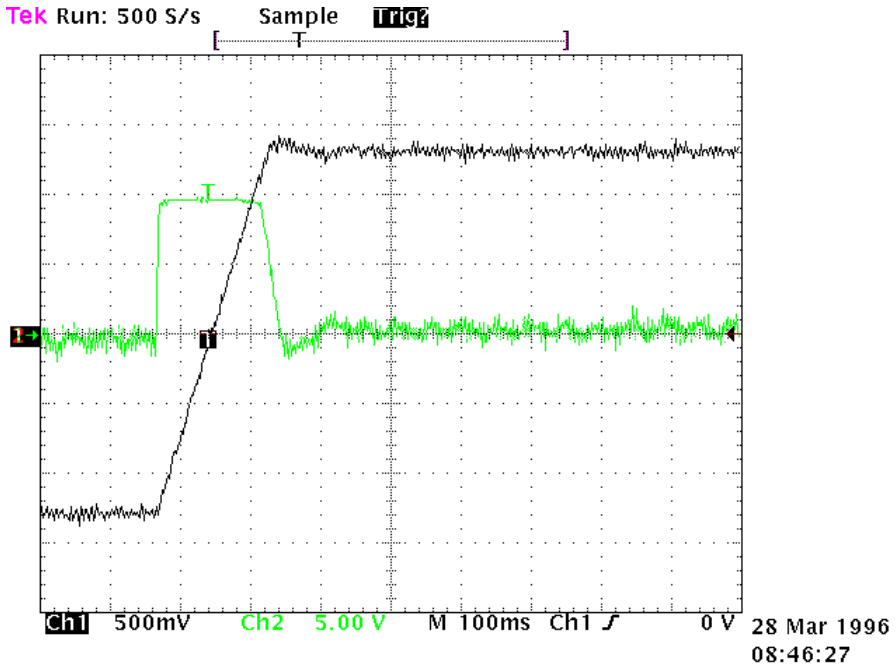


Fig. 5

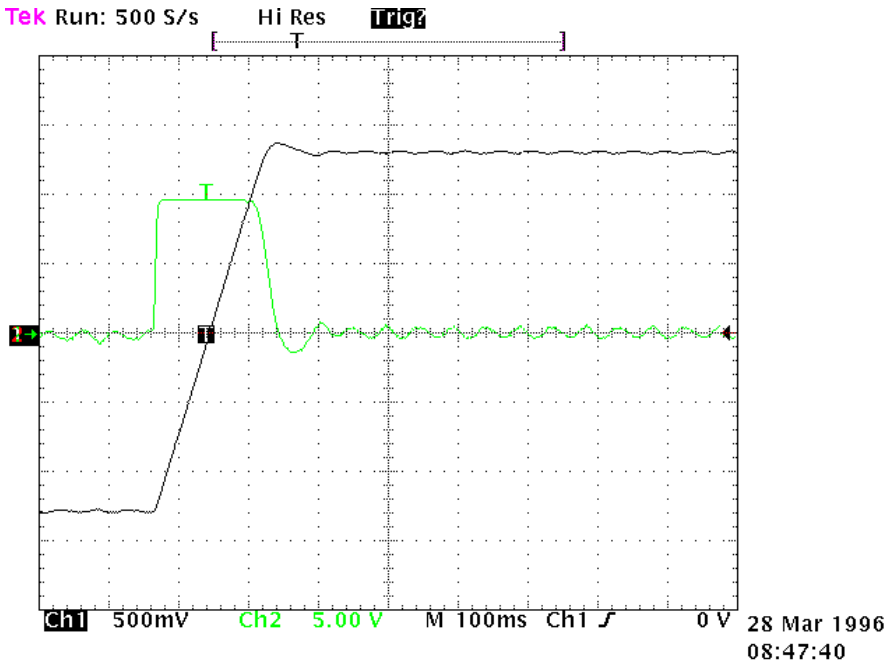


Fig. 6

If mechanical parts are used which very easily tend to enter into oscillation, we recommend you use very low values of Pr16. In this configuration the SLVD typically dampens the torque request of the motor in order to avoid triggering mechanical oscillations. This configuration is shown in figure 7.

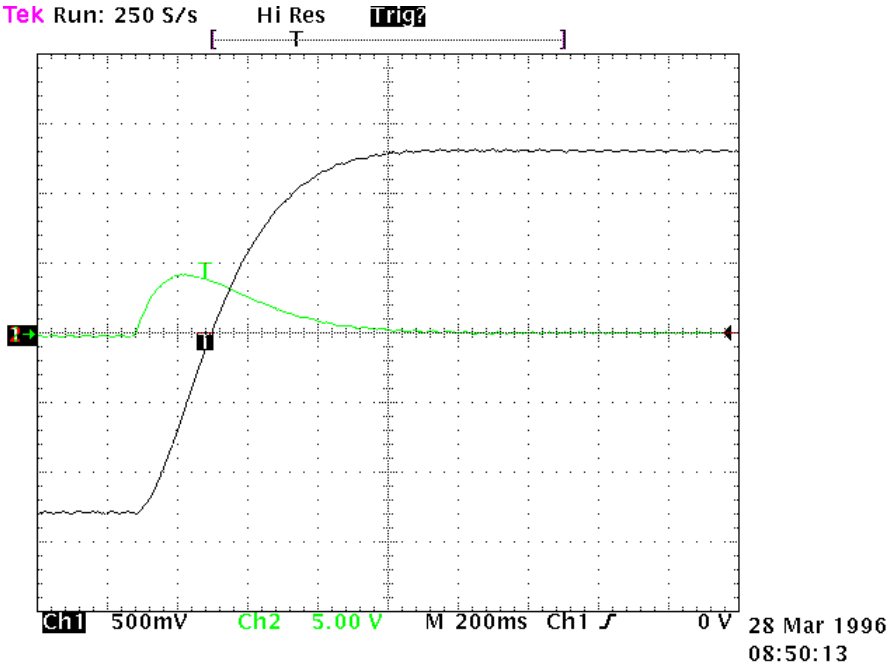


Fig. 7

ADJUSTMENT WITHOUT USING INSTRUMENTATION

If you do not have an oscilloscope, you must:
A) Determine the value of Pr16 as described above.
B) Determine the Pr17 parameter by using the following formula:

$$\mathrm{Pr}17 = 1488 \cdot \sqrt{\frac{153.41 \cdot \mathrm{Pr}16 \cdot J_{tot}}{Nm_{picco}}}$$

where: J_{tot} is the total inertia (motor + load) expressed in kgm^2.

Nm_{picco} is the available torque with the peak current of the converter.

C) Turn on the converter and use the external control to move the axis. Move Pr17 to find the value where the axis seems to move best.
D) Estimate the value of Pr18 by using the following formula:

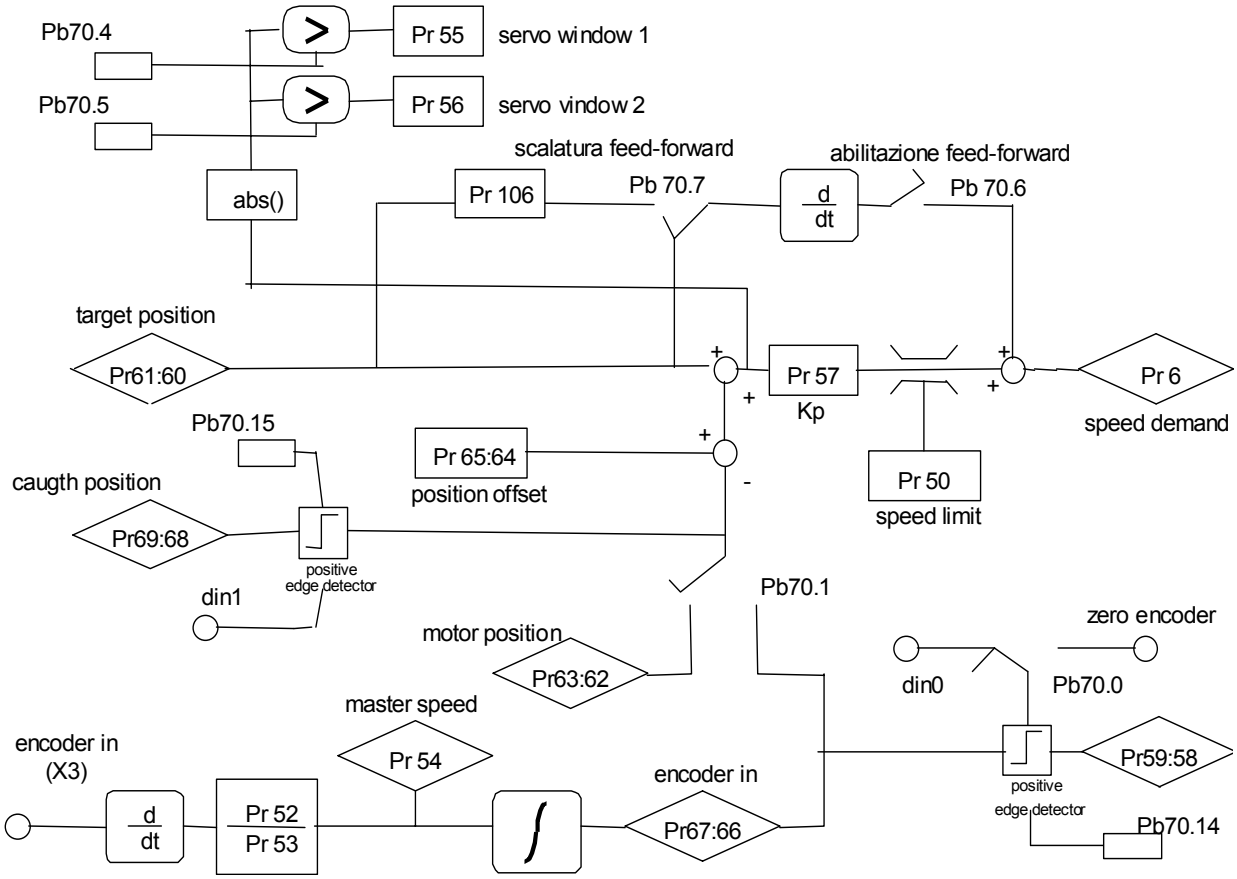
$$\mathrm{Pr}18 = 0.68 \cdot \frac{\mathrm{Pr}17}{\mathrm{Pr}16}$$

If the result is less than 1, Pr18 must be set to 1.

If the adjustment is not satisfactory, repeat the procedure with lower values of Pr16.

3.7 Operating modes

Parameter Pr31 (default = 0) is used to select the operating mode. Every operating mode controls speed using parameter Pr6 and can use parameter PR21 to limit the torque at the motor (see the block diagram). Speed control will use as reference Pr7 or Pr6, depending on the value of b40.2. Before changing Pr31, b40.2 must be set to 0 in order to avoid unwanted movements of the motor. Therefore, it is possible to set Pr31 to the value that corresponds to the selected operating mode. The parameter b99.11 is used to load the default parameters for the selected operating mode. By setting b40.2 to 1, the operating mode will be turned on. All operating modes need to control the motor in position (13, 14, 15) by using the position loop described in the diagram in the figure.



Pr50 **Maximum speed**. Unit = rpm, default = 3000, range = 0...9000. This parameter limits the maximum speed of the motor. It can be useful to limit the speed during a sudden link or during a quick change of speed.

Pr51 **Position error**. Range = -32768...+32767.

Pr52 **Reference multiplier.** Default = 1, range = -32000...+32000. Using this parameter and Pr53, the user can set the ratio desired for the input reference frequency.

Pr53 **Reference divider.** Default = 1, range = -32000...+32000. Using this parameter and Pr52, the user can set the ratio desired for the input reference frequency.

Pr54 **Encoder-in rotation speed (read-only)**. Unit = rpm. Indicates the input reference frequency translated into rpm (based on 4096 imp/revolution).

Pr55 **Window for servo-error 1**. Unit = steps, default = 1000. If the position error as an absolute value exceeds the value set in Pr55, b70.4 is set to 1. Otherwise, b 70.4 = 0.

Pr56 **Window for servo-error 2**. Unit = steps, default = 1000. If the position error as an absolute value exceeds the value set in Pr56, b70.5 is set to 1. Otherwise, b 70.5 = 0.

Pr57 **Proportional gain for the position regulator.** Default = 100, range 0..32000.

Pr58:59 **Encoder in captured.** Unit = steps. The value encoder master is captured on the positive edge of the selected input (see b70.0).

Pr60:61 **Regulator position reference.** Unit = steps.

Pr62:63 **Motor position** (resolver). Unit = steps. If incremented by 4096 steps per revolution.

Pr64:65 **Position offset**. Unit = steps.

Pr66:67 **Encoder-in counter**. Unit = steps.

Pr68:69 **Value captured**. Value of the position of the motor captured on the positive end of the input (X1-10). Unit = steps.

Pr106 **Feed forward scale**. Default =0, the range is: from 0 to 2000, but if Pr106=1000 the feed forward doesn't use the scale.

B70.0 **Encoder in capture**. Default = 0. If = 0, the capture of the value encoder master is made from input 0 (X1-9). Otherwise, it is made by the input of the zero trace encoder (X3) (see o*perating mode 14*).

B70.1 **Feedback.** Default = 0. If = 0, feedback is done by the resolver. If = 1, feedback is done by the encoder (X3). In this last case, the parameters Pr52 and Pr53 serve to rate the pulses per revolution at 4096.

B70.2 **Feedback direction.** Default = 0. If = 1, the rotation of the motor is inverted. Only with feedback done by the resolver.

B70.4 **Servo error**. B70.4 will be set to 1 if the position error as an absolute value exceeds the value set in Pr55.

B70.5 **Servo error**. B70.5 will be set to 1 if the position error as an absolute value exceeds the value set in Pr56.

B70.6 **Feed-forward enable**. If set to 1, the feed-forward on the position regulator is enabled.

B70.7 **Feed forward scale enable.** If B70.6=1, is possible enable the feed forward scale.

B70.13 **Monitor error**. If set to 1, Pr38 = Pr51 / 2^{Pr89}.

B70.14 **Value master captured**. If set to 1, this means that the value master has been captured. The user must set the bit to 1 (see o*perating mode 14*).

B70.15 **Value motor captured**. If set to 1, this means that the value motor has been captured. The user must set the bit to 1.

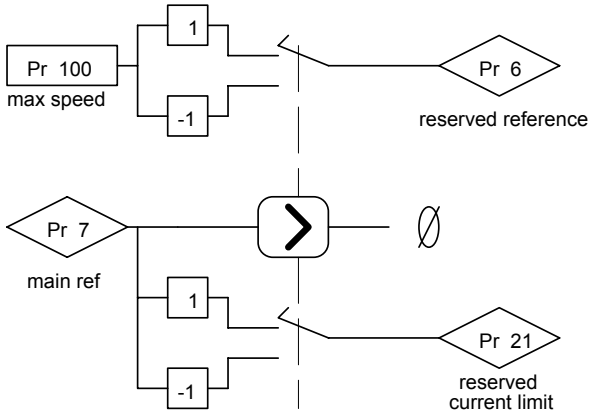
3.8 Torque control (operating mode 1)

This operating mode does not control the torque in the classic way since the speed control continues to work to control the speed limit. The torque reference will be the Pr7 main reference. To set up the torque control, you must first adjust the speed control in order to establish a stable system and then set Pr31 = 1 in order to program the operating mode by setting the default values with the command b99.11. Set Pr2 = 1000 (10 V = 100.0 % of the torque), b40.0 = 0, b40.12 = 0, b40.2 = 1 to enable the reserved reference and Pr100 to limit the maximum speed of the motor.

OPERATING MODE 1 PARAMETERS

Pr100 **Maximum speed.** Unit = rpm, default = 3000, range = 0..9000. This parameter is used to limit the absolute maximum speed of the motor during the torque function.

opm 1 for sLVD drive



3.9 Digital Lock + Positioner (operating mode 13)

Operating mode 13 includes the Digital Lock, dynamic positioner and flow speed functions in order to use them at the same time. The tracking function refers to the input frequency signal (X3 connector) set as an input encoder signal by setting b42.0 = 0, b42.1 =1, and b42.5 = 1. This encoder signal is counted at every end of the communication of A and B signals. The counter of the motor position is incremented at the rate of 4096 steps per revolution. The user can program the ratio between the master and the slave by using parameters Pr52 and Pr53. It is possible to choose the ramp to use during the engaging or release phase (Pr103). The main ramps and the internal PLC can be used to program different engaging and release modes with or without phase recovery. See the connection diagrams in the section, *Input frequency connection*. If you use a digital input for the engaging command, the digital input 0 in FAST-IN mode must be used in order to minimize phase errors.

The positioner function follows a trapezoidal profile in which the acceleration and deceleration ramps are defined by Pr109, the full speed by Pr108 and the final position by Pr118:119 (one revolution of the motor equals 4096 steps). The parameters can be modified at any time. The current position of the positioner is given by the parameter Pr116:117.

You can add a speed by using Pr104.

OPERATING MODE 13 PARAMETERS

Pr103 **Acceleration and deceleration ramp (el. Axis)**. Unit = s/krpm, default = 500, range = 0..30000, resolution =one thousandth of a second. The acceleration and deceleration required for the motor can be limited in order to achieve a jump of 1000 rpm that takes Pr103 thousandths of a second. This can be useful when the axis is suddenly attached.

Pr104 **Addition speed**. Default=0, range 0..±6000.

Pr108 **Full speed (positioner)**. Unit = rpm, default=1000, range = 0..+9000. This is the full speed that will be used during the generation of the position profile.

Pr109 **Acceleration time (positioner)**. Unit = s/krpm, range = 0.002..30.000, resolution =0.001s, default=0.500 s. This is the acceleration ramp that will be used during the positioning profile.

Pr114:115 **Actual position (electrical shaft)**. Unit = steps; read-only parameter. Indicates the actual position with reference to the electrical shaft.

Pr116:117 **Actual position (positioner)**. Unit = steps; read-only parameter. Indicates the actual position with reference to the trapezoidal profile.

Pr118:119 **Final position (positioner)**. Unit = steps; used to set the final position that is desired for the generator of the trapezoidal profile, based on 4096 steps per revolution.

B150.0 **Active positioner.** During the positioning (Pr118:119 ≠ Pr116:117) this bit is high.

B150.2 **Engaged electrical shaft.** During the engaging phase when the ramp (Pr103) is not 0, this bit indicates the end of the transitory phase.

B150.3 **Encoder in selection.** If 0, the encoder input, conditioned by Pr52 and Pr53, is used as the master for the electrical axis function. If 1, it updates directly Pr118:119 to execute the step like function or pulses train.

B150.4 **Profile direction.** Read-only flag. Indicates the direction of the motion of the positioner.

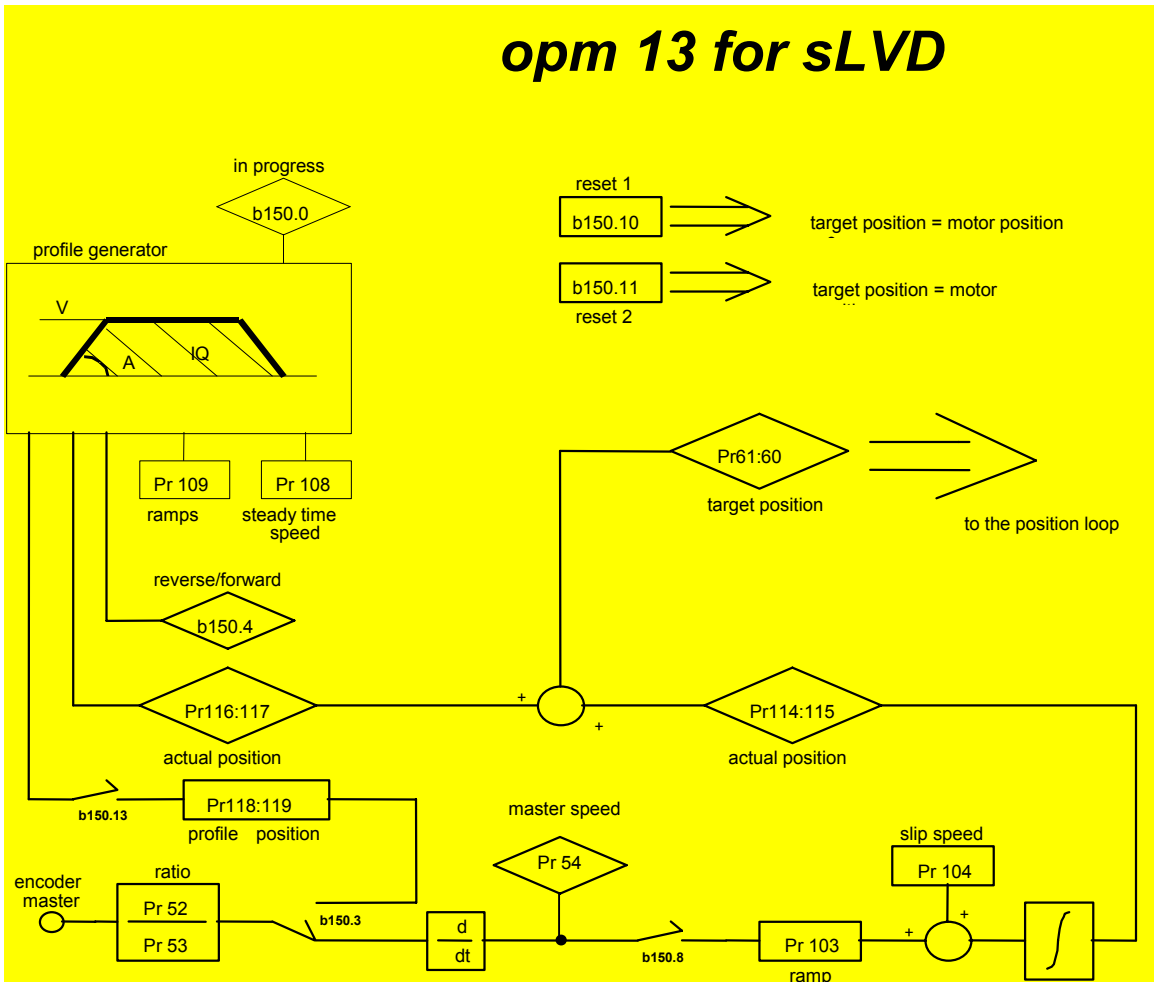
B150.6 **Profile feed-forward.** Default=0. If 1 the profile feed-forward is disabled.

B150.8 **El. Axis engaging/release.** This bit it used to engage (= 1) and release (= 0) the axis from the input encoder reference.

B150.10 **Type 1 reset**. Command to set all the motor position and reference to 0.

B150.11 **Type 2 reset**. Command that sets the position of the motor shaft (Pr62:63) to the main reference (Pr60:61) and of the positioner (Pr116:117) by setting that of the electrical shaft to 0.

B150.13 **Final position evaluation enable/disable (Pr118:119).** Default = 1. If 0, eventual modifications to Pr118:119 will not be considered.



3.10 Electronic cam (operating mode 14)

Operating mode 14 was expressly designed to meet the needs of packaging machines that require electronic cams. The table of the cam function is described with a vector composed of 257 elements, each of which indicates the position that must be assumed by the controlled axis when the master axis is in the position (element_number * master_module) / 256. The value of the elements of the vector falls within the range 0 – 9999, where 10000 corresponds to the number of counts set in the slave module parameter. The 257th element defines the cam as closed if it = 0, or as open if it = 10000.

The mode selector can be used to select the source for the position loop. The possible sources are: no source, positioning, electronic cam and speed.

POSITIONING. The parameters that regulate movement are: target_pos, acc, speed. Target_pos indicates the absolute position that is to be achieved; if it is included in the movement direction module, it is given by the sign of the difference between target_pos and Pr60:61. Acc is the maximum acceleration allowed during the movement and speed is the maximum speed. The path generator will begin its work when the mode selector is set to 1. When the position has been achieved, the mode selector automatically returns to 0. Alternatively, the positioner module can be used to sum a phase on the master axis by setting target_pos based on the actual offset phase position Pr116:117. At the start the calculation of the path will be such as to guarantee continuity with the actual speed of the motor.

MASTER REPHASING. By setting the function (b150.8) the user can define the position of the master (Pr122:123) on the positive side of digital input 0 or of the zero trace encoder input (selector b70.0); b70.14 indicates that the initialise has been achieved. The user must set this flag to 0. For this function b42.0 must be 0 and b42.1 must be (see section *Frequency input/output connection*).

CAM ENGAGING. A master phase can be defined to which the selector will automatically be set to position 2 by enabling the cam module. A similar procedure can be used for release. In this case, when the release phase has been programmed, the positioner will be enabled to reach the desired position. The functioning of operating mode 14 is described in detail in the block diagram. It is also possible to engage cam phase with a linear ramp by mean of command 150.11. Using this command it is necessary that the master is running positive way, that is to say the master position counter is increasing. It is also necessary to set in Pr 132:133 the master position at which the slave axis starts moving , the distance to be covered by the slave during the acceleration ramp in Pr 136:137 , the position of the master at which the cam is engaged in Pr 126:127. Of course in this case the position reached by the slave axis at the end of the ramp (slave starting position + pr136:137) should be the same of the position set in the cam table corresponding to master position Pr126:127 that is to say starting position of slave axis must be less than engage cam phase position of the distance set in Pr136:137. The position of slave axis corresponding to present phase of master axis can be read dynamically in Pr134:135. The 150.11 command is reset when the slave axis starts moving and in the meantime 150.12 is set. It is up to the user to ensure that the speed of the slave axis is continuous at the engage phase. Three functions are pre-defined that can be used to set the cam profile. By setting Pr102 = 5, the function is y = x, Pr102=6 the function is y = x-sinx, Pr102=7 the function is y = sinx where y is rated to 10000 on the 256 points of the cam. The compilation of the cam table is done in the background and at the conclusion Pr102 is set to 0. Make sure that if b40.2=0, the parameter Pr102 is nevertheless forced to 0.

Pr100 **Speed in speed mode.** Default = 0, range 0..±6000.

Pr101 **Ramp time for Pr100**. Unit = s/krpm, range = 0.002..30.000, resolution = 0.001s, default=0.500 s. This is the acceleration ramp that will be used by the speed mode.

Pr102 **Function selector.** Default=0, range 0..3. Enables the functioning as: a halted motor, positioning, electronic cam and speed.

Pr103 **Pointer to the cam table.** Default=257, range 0..257. Pr103 is used to access the cam table. Pr104 will contain the value of the Pr103th element in the table.

Pr104 **Table element value.** Default=0, range 0..10000. Pr104 is the value of the Pr103th element in the table.

Pr108 **Full speed (positioner)**. Unit = rpm, default=1000, range =0..+9000. This is the full speed that will be used during the generation of the position profile.

Pr109 **Acceleration time (positioner)**. Unit=s/krpm, range =0.002..30.000, resolution =0.001s, default=0.500 s. This is the acceleration ramp that will be used during the positioning profile.

Pr110:111 **Master axis module**. Unit = steps; range $0..2^{18}$ Default=10000. This is the value of the master axis module.

Pr112:113 **Master axis position**. Unit = steps; this is the present position of the master axis.

Pr114:115 **Slave axis module**. Unit = steps; range $0..2^{18}$ Default=10000. This is the value of the slave axis module.

Pr116:117 **Master position offset**. Unit=steps; range $0..2^{23}$, default=0.

Pr118:119 **Final position (positioner)**. Unit = steps; the parameter used to set the final position desired for the generator of the trapezoidal profile, based on 4096 steps per revolution.

Pr122:123 **Master axis phase**. Unit = steps; range $0..2^{23}$ Default=0. If b150.8 = 1 at the first positive front of digital input 0 or of the zero encoder input (see the block diagram), the position of the master axis become Pr122:123.

Pr124:125 **Master axis phase captured.** Unit = steps; range $0..2^{23}$ Default=0. At each positive front of digital input 0 or of the zero encoder input (see the block diagram), the position of the master axis is copied into in Pr124:125.

Pr126:127 **Master axis phase for engaging.** Unit = steps; range $0..2^{23}$ Default=0. If b150.12 = 1, when the position of the master Pr112:113 exceeds Pr126:127, Pr102 is brought to position 2 and b150.12 returns to 0 to indicate that engaging has been achieved.

Pr128:129 **Master axis phase for release.** Unit = steps; range $0..2^{23}$ Default=0. If b150.13=1, when the position of the master Pr112:113 exceeds Pr128:129, Pr102 is brought to position 1 and b150.13 returns to 0 to indicate that the positioner has been enabled and will control the release phase.

Pr132:133 **Engage cam with ramp**. Unit=steps; range $0..2^{23}$, default=0. This is the position on which the engage ramp related to the master starts.

Pr134:135 **Slave cam position**. Unit=steps; range $0..2^{23}$. Read only parameter that shows the position at the output of the cam.

Pr136:137 **Engage cam ramp**. Unit=steps; range 0..2^{15}, default=0. This is the step value performed by the slave during the engage ramp; the value must be less then an half of the slave axis module.

B150.2 **Position loop.** Default=0. If = 1 the position loop works on absolute positions, otherwise on slave axis module.

B150.3 **Master phase-shift command.** Default=0. If = 1, the positioner module is used to change the phase between the master and the slave or as the generator of the virtual axis. When the final position Pr118:119 equals Pr116:117, this bit is automatically set to 0. Do not use this command together with Pr102=1.

B150.6 **Encoder input enable (X3).** Default=1. If = 1, the reading of the encoder master is enabled.

B150.8 **Phase master axis enable.** Default=0. If = 1, the copying of parameter Pr122:123 to Pr112:113 to the first front of the rise of input 0 or the zero encoder is enabled.

B150.10 **Type 1 reset**. Command to set all the motor positions and references to 0.

B150.11 **Cam engaging in phase with ramp.** Command to engage the cam movement when the master reaches the level of Pr126:127 with a ramp defined by the parameters Pr132:133 and Pr136:137.

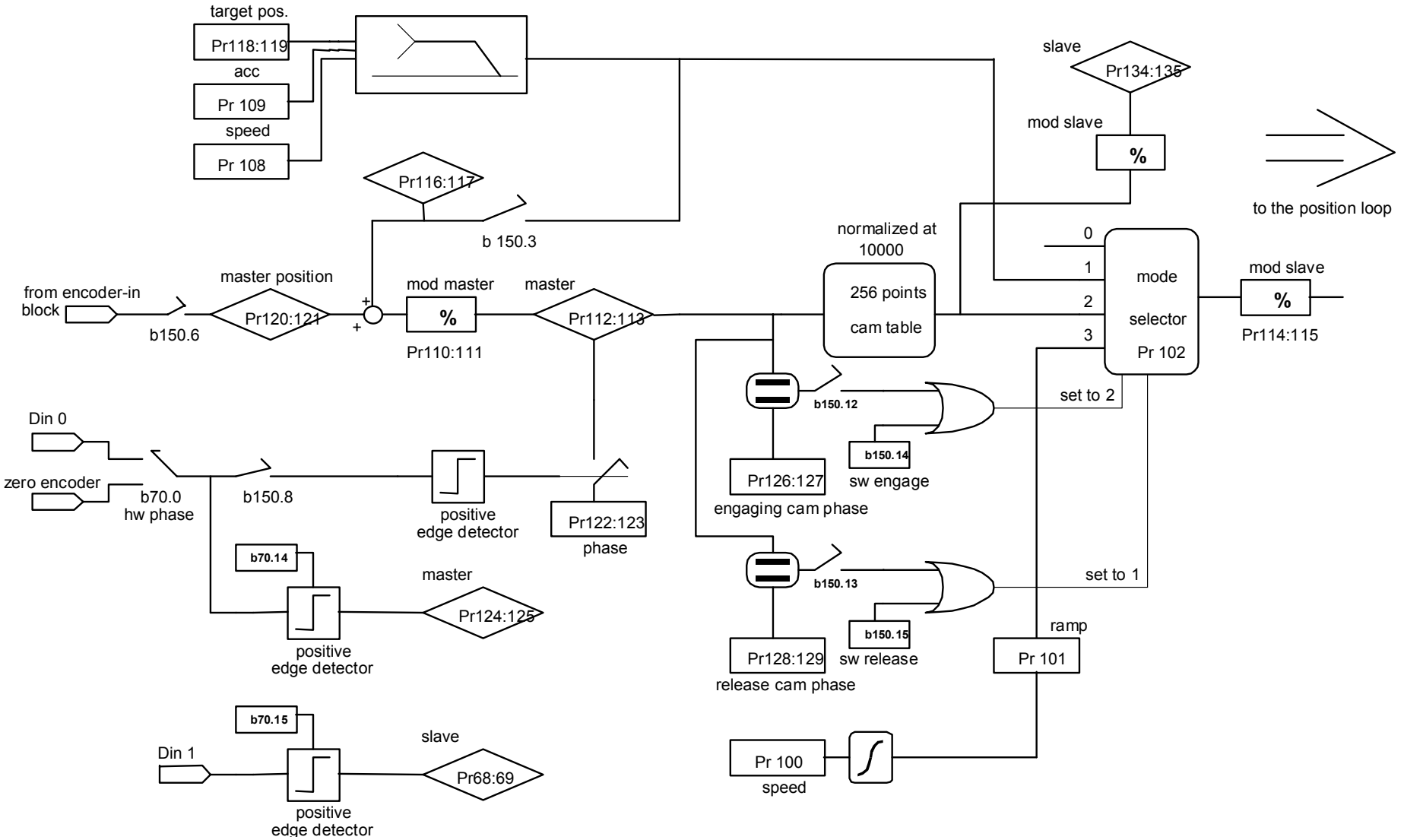
B150.12 **Electronic cam engaging in phase.** Command to engage the cam movement when the master reaches the level of Pr126:127. This bit is automatically set to 0 when the command has been enabled.

B150.13 **Electronic cam release in phase.** Command to release the cam movement when the master reaches the level of Pr128:129. This bit is automatically set to 0 when the command has been enabled.

B150.14 **Immediate electronic cam engaging.** Command to engage the cam movement. This bit is automatically set to 0 when the command has been enabled.

B150.15 **Immediate electronic cam release.** Command to release the cam movement This bit is automatically set to 0 when the command has been enabled.

opm 14 for sLVD drive



3.11 Position control through the CanBus (operating mode 15)

If operating mode 15 is enabled, the sLVD will execute a position loop of a proportional type with feed-forward. In this case the generator of profiles is considered external and must send the information about the position and speed reference via CanBus in accordance with the SBCCAN protocol (see the section on the CanBus). If b70.1 = 0, feedback is provided by the resolver. If b70.1 = 1, the feedback is provided by the encoder (X3).

OPERATING MODE 15 PARAMETERS

Pr102 **CanBus commands** (see the section on the CanBus).

Pr103 **CanBus status** (see the section on the CanBus).

Pr104 **Feed-forward speed**. Unit = rpm, default=0, range =0..±9000. The value of this parameter is summed at the output of the position loop in order to obtain the speed request Pr6.

Pr105 **Feed-forward speed via CanBus**. This is the feed-forward value received via the CanBus. When the SYNC (Pb150.8=1) is received, Pr105 will be copied to Pr104 and will become active.

Pr114:115 **Position reference via CanBus**. This is the position reference received via the CanBus. When the SYNC (Pb150.8=1) is received, Pr114:115 will be copied to Pr60:61 and will become active.

Pr116:117 **Motor position via the CanBus**. When the SYNC (Pb150.8=1) is received, Pr62:63 will be copied to Pr116:117 and, if feedback transmission has been enabled (b150.2=1), it will automatically be transmitted via the CanBus.

B150.2 **Feedback transmission enable**. Default=0. If = 1, when the type 0 SYNC is received, Pr116:117 will be transmitted via the CanBus.

B150.3 **Reply status**. Default=0. If 0, the cyclic reply uses 16 bit status (Pr103); if 1, the cyclic reply status is a byte equal to the first 8 bit of Pr103.

B150.4 **Low speed mode.** Default=0. In the case of Pr48=0: if b150.4=1, the speed of the functioning mode of the CanBus in real time will be set to 500kbps, otherwise, the same mode will have the speed of 1Mbps.

B150.6 **Feedback transmission enable**. Default=0. If = 1, when the type 1 SYNC is received, Pr116:117 will be transmitted via the CanBus.

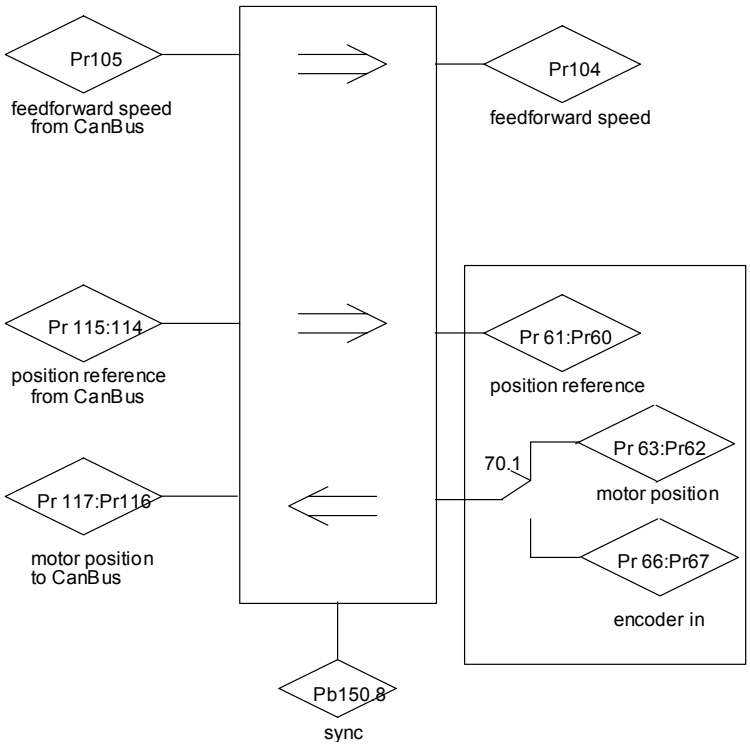
B150.8 **Sync**. The command via the CanBus of synchronism sets b150.8 to 1, thereby allowing the torque of Pr105 on Pr104, Pr115:114 on Pr61:60 and Pr63:62 on Pr117:116. The references of the position control are updated and after this procedure b150.8 is automatically set to 0.

B150.10 **Type 1 reset**. Command to set the motor positions and reference to 0.

B150.11 **Type 2 reset**. Command that sets the motor position and the reference to the position of the motor shaft Pr28 and Pr64:65 to 0.

B150.12 **Type 3 reset**. Command that copies the motor position to the reference and sets Pr64:65 to 0.

opm 15 for sLVD drive



Pb150.10 target position = motor position = 0
reset 1

Pb150.2
enable auto-answer sync 0

Pb150.4
realtime mode low speed

Pb150.6
enable auto-answer sync 1

3.12 Additional useful functions

3.12.1 Value comparators

These functions are enabled ONLY with operating mode 13 and 14. The Pr96:95 and Pr98:97 parameters have the alternative function of value comparators.

With b94.10 = 0, then b94.8 = 1 if Pr96:95 > Pr63:62 (or Pr66:67 if feedback encoder)

With b94.10 = 1, then b94.8 = 1 if Pr96:95 > Pr61:60

With b94.11 = 0, then b94.9 = 1 if Pr98:97 > Pr63:62 (or Pr66:67 if feedback encoder)

With b94.11 = 1, then b94.9 = 1 if Pr98:97 > Pr61:60

This function is run every 6.144 ms.

If the value comparators functions are not used, the Pr95, Pr96, Pr97, Pr98, b94.10 and b94.11 parameters by the PLC program as general purpose registers.

3.12.2 Value capture

At every positive front of digital input 0, the value of Pr63:62 (or Pr66:67) is captured and stored in Pr68:69 and b70.15 is set to 1 to signal the event. B70.15 is not reset automatically but must be executed by the pico-PLC or the serial line.

Analogous situation, at every positive front of digital input 0, the value of Pr66:67 is captured and stored in Pr58:59 and b70.14 is set to 1 to signal the event. B70.14 is not reset automatically but must be executed by the pico-PLC or the serial line.

3.12.3 Virtual encoder

The virtual encoder function is enabled by setting b42.0 = 1, 42.1 = 0 and 42.5 = 1. A virtual encoder will be available at the X3 connector and its speed will be as set in Pr3. The set speed has a resolution equal to 1 rpm and a value in the range –3500 and +3500 rpm. The output signals (phase A, phase B) will simulate an encoder of Pr44 steps/revolution, without phase C of 0.

After the programming, the configuration must be saved and the unit must be powered off and on again.

3.12.4 Output cam programmer

This function gives a digital output (pin 8 X4) according to the present position of the motor in a module. The user has to set the value corresponding to the module in Pr144:145. Inside the module can be defined 2 further values (Pr146:147 and Pr148:149) indicating the position at which the digital output is toggled. The user has to initialise the value of the motor position at Pr142:143 and the output status at b91.1; the function is enabled by b70.3=1 and in this case Pr142:143 shows the motor position inside the module. An offset for this position may be set at Pr140. The refresh time of the digital output is 512 μs. The limits for the parameter values are:

Pr140 : range $-2^{15}\ldots 2^{15}$

Pr142 :143 : range $0\ldots 2^{31}$

Pr144 :145 : range $0\ldots 2^{31}$

Pr146 :147 : range $0\ldots 2^{31}$

Pr148 :149 : range $0…2^{31}$
0 =< Pr146 :147 =< Pr148 :149 =< Pr144 :145.

3.12.5 Homing function

The homing function, which is available exclusively with operating modes 13, 14 and 15, provides a typical axis reset procedure. Before using the homing function perform the following settings:
- connect the homing sensor to digital input 3
- set the homing speed in parameter Pr4 (pay attention to the direction of rotation)
- set Pr5 = 0, b40.12=1, b40.13=0, b40.2=0.

To activate the homing procedure set b94.12=1 for a type 1 reset, or b94.13=1 for a type 2 reset. When the homing procedure is concluded the respective activation bit will be reset. If you wish to abort the procedure, reset the command bit, stop the motor (e.g. by resetting Pr5) and, if necessary, read b40.2 which will remain on zero.

RESET TYPE 1 - DESCRIPTION

When the procedure is activated (b94.12=1) the axis is brought to the speed programmed in Pr4 (Pr5=Pr4); the axis is then brought to zero speed (Pr5=0) on the positive front of the homing sensor signal; after 150ms with the motor stopped parameters Pr61:60 and Pr63:62 are reset, the position loop is enabled by setting b40.2=1, and command b94.12 is reset. The homing sensor signal must be maintained active in high status for the entire duration of the motor stopping phase.

If the homing sensor is already engaged when the procedure is activated, the axis moves at the speed programmed in Pr4 but in the opposite direction until the homing sensor is freed; At this point the procedure continues as described above.

RESET TYPE 2 - DESCRIPTION

When the procedure is activated (b94.13=1) the axis is brought to the speed programmed in Pr4 (Pr5=Pr4); the axis is then brought to zero speed (Pr5=0) on the positive front of the homing sensor signal; after 150ms with the motor stopped parameters Pr61:60 and Pr63:62 are programmed with the value of parameter Pr28, the position loop is enabled by setting b40.2=1, and command b94.13 is reset. The homing sensor signal must be maintained active in high status for the entire duration of the motor stopping phase.

If the homing sensor is already engaged when the procedure is activated, the axis moves at the speed programmed in Pr4 but in the opposite direction until the homing sensor is freed; At this point the procedure continues as described above.

3.12.6 Encoder Can

If this function is enable, it is possible to generate and receive the "encoder like" signals by the CAN line, which replaces quadratures signal.

The running is trasparent, respect to the traditional encoder signals:the CAN line must be connected instead of quadratures signals, and must be considered that every encoder signal is available every 1,024msec over the CAN, and the signal has 4byte for data.

It is possible to have up to a maximun of three encoder signals, if the speed of the CAN is 1Mbs, and only one encoder signal if the speed is 500kbs.

sLVD drive needs some bit and parameters about the correct operation:

- Pb70.8: enable the encoder CAN function, it activates at the succesive switching on after save the setting of the bit.
- Pb70.9: selects the counter by CAN or encoder input for the OPM.
- Pb70.10: enable the encoder CAN virtual through the parameter pointed from Pr158.
- Pr154: reduction ratio numerator of the input encoder counting by CAN.
- Pr155: reduction ratio denominator of the input encoder counting by CAN.
- Pr156:157: countig encoder CAN
- Pr158: pointer to the parameter to send as virtual encoder on the CAN.

If the encoder CAN function is activated, Pb70.8=1, the encoder traditional is setting only as indipendent input from Pb42.1 status. The encoder CAN is active in input and accepts the CAN signal with address setting into Pr44.

The output encoder CAN is enable if Pb42.1=0 and it generates a encoder signal with the same address to CAN node. The CAN node address regarding SBC protocol is the value Pr27+1.

If the address of the input encoder (Pr44) is setting at the same value of the output address (Pr27+1), the axe wich generates the encoder CAN, reads input the encoder CAN output signal.

If the command Pb42.0 is enable, is possible to generate a encoder virtual signal. But differently to encoder traditional, setting B70.10=1 the reference isn't the speed into Pr3 but is the position into the parameter pointed from Pr158.

The parameter of the encoder speed input, Pr54, is the reference for the encoder traditional if Pb70.9=0 but is the refence for the encoder CAN if PB70.8=1 and Pb70.9=1.

The bit Pb39.15 is watchdog bit for encoder CAN, and every time that an encoder message arrives the status is 1.

If the encoder CAN function is activated, the number of the free parameter decrease. See the next table.

PAR	MIN	MAX	DEF	DESCRIPTION
151	-2^{31}	2^{31}		Custom
152	-2^{31}	2^{31}		Custom or CANopen user emgy messagge
153	-2^{31}	2^{31}		Custom or CANopen user emgy messagge
154	-2^{31}	2^{31}		Custom or ratio numerator encoder in CAN
155	-2^{31}	2^{31}		Custom or ratio denominator encoder in CAN
156	-2^{31}	2^{31}		Custom or encoder CAN counter
157	-2^{31}	2^{31}		Custom or encoder CAN counter
158	-2^{31}	2^{31}		Custom or pointer for encoder out via CAN
159	-2^{31}	2^{31}		Custom
160	-2^{31}	2^{31}		Custom
161	-2^{31}	2^{31}		Custom
162	-2^{31}	2^{31}		Custom
163	-2^{31}	2^{31}		Custom

3.12.7 Feedback from incremental encoder

In place of the resolver it is possible to use an incremental encoder, which provides feedback for both speed control and space. If possible select the feedback from encoder instead of resolver, setting Pb42.6=1. Modifications at this bit are available only after restarting of the drive. The encoder input signals are on the terminal X3 and made reference to the section "frequency input/output connection". (Pb42.0=0, Pb42.1=1 and Pb42.5=1). The encoder can be powered by external supply.
The phasing procedure must be run upon every drive start up.
It's possible choose among two type of procedure, and it's necessary that the motor must be free to rotate, also when the motor is mounted into the system (the brake of the motor must be disable). During the phasing procedure 1, the drive checks the connections, and the movement of the motor is brodest, so this procedure is recommended for the first time.

PROCEDURE 1
Pb94.2 actives this procedure. The parameters are shown in the table below:

Par.	Description	Field/Unit	Def.	Type/ Notes
Pb94.2	**Command phasing 1**. ; It's necessary to disable he software (Pb40.9=0); enable the hardware (Pb41.5=1), and driver OK (Pr23=0). The motor executes two movements and the last is about 90° degree electric, with control sign of the encoder feedback. Introduce the correct number of the motor poles (Pr29).		0	
Pr 52 Pr 53	Used to normalise the number of encoder pulses on the motor shaft revolutions to the standard value 65536, through the following relation: (Pr52/Pr53)*(encoder pulses/motor shaft revolutions x4)=65536 The sign determines the feedback (positive or neg.)	±32767	1	R/W M
Pr89	**Status**: 0 if positive result 2 if wrong enabling 3 if positive feedback 4 if wrong motor poles (tolerance ±22.5 electric degrees) 5 if drive not ready (Pr23 ≠0 or open inr ush)			R
Pb41.4	In case of negative result, the Pb41.4 remains to zero (driver not OK).		0	R
Pb42.6	=1, select the feedback from encoder		0	M
Pb41.6	Phasing result :=1 if positive result of the procedure and necessary condition for drive OK (Pb41.4)		0	R

PROCEDURE 2:
Pb94.4 actives this procedure. The parameters are shown in the table below:

Par.	Description	Field/Unit	Def	Type/ Notes
Pb94.4	**Command phasing 2**. ; It's necessary to disable he software (Pb40.9=0); enable the hardware (Pb41.5=1), and driver OK (Pr23=0). The motor executes a vibration, the standing depends to the type of the motor and to the load.		0	
Pr 52 Pr 53	Used to normalise the number of encoder pulses on the motor shaft revolutions to the standard value 65536, through the following relation: (Pr52/Pr53)*(encoder pulses/motor shaft revolutions x4)=65536 The sign determines the feedback (positive or neg.)	±32767	1	R/W M
Pr89	**Status**: 0 if positive result 2 if wrong enabling 5 if drive not ready (Pr23 ≠0 or open inr ush) 6 Pr30 parameter caculated (frequency of vibration) is different of 25 unit from starting value 7 Pr30 parameter caculated (frequency of vibration) exceeds 200 unità (max. value)			R
Pb41.4	In case of negative result, the Pb41.4 remains to zero (driver not OK).		0	R
Pb42.6	=1, select the feedback from encoder		0	M
Pb41.6	Phasing result :=1 if positive result of the procedure and necessary condition for drive OK (Pb41.4)		0	R

The calculated value of Pr30 at the end fo the procedure, if it is save, it permits at the new start-up that the procedure starts from this value, and if the mechanical conditions don't change, is maked only one vibration of standing fixed by Pr30.

N.B.: *(*) during the phasing procedure the motor must be motionless, so if the motor is on vertical axe, this system must be motionless without to use the brake.*
(**) the encoder simulation can't use zero encoder track as reference for reset the machine, when the system uses a axis control and the FBK is a incremental encoder.

4 PROGRAMMING DIGITAL INPUTS AND OUTPUTS

4.1 The pico-PLC

The internal pico-PLC is used to connect the external world (inputs/outputs) with the world of the parameters of the SLVD. The PLC can be used to copy digital input to a binary parameter, to copy a binary parameter to a digital output and to execute mathematical and Boolean operations. The PLC program must be inserted as a list of instructions by using the keyboard or by the serial line using a PC and an interface program. A PLC program (see *Appendix F*) written to meet the needs of a large number of applications corresponds to the default parameters (b99.12). In most cases it is not necessary to program the PLC itself. The main features of the pico-PLC are:

program steps	**128**
scanning time	**6.144 ms**
number of timers	**2**
number of instructions	**15**
stack depth	**1**
mathematical operations	**16 / 32 bits**
fast inputs	**2 – (512 μs)**

PLC PARAMETERS

Pr71 **Constant value = -1.** Double word.
Pr72 **Constant value = 0.** Double word.
Pr73 **Constant value = 1.** Double word.
Pr74 **Constant value = 2.** Double word.
Pr75 **Constant value = 10.** Double word.
Pr76 **Constant value = 100.** Double word.
Pr77 **Constant value = 1000.** Double word.
Pr78 **Constant value = 1024.** Double word.
Pr79 **Constant value = 4096.** Double word.
Pr80 **Free parameter.** A parameter that can be stored by the user (word).
Pr81 **Free parameter.** A parameter that can be stored by the user (word).
Pr82 **Free parameter.** A parameter that can be stored by the user (word).
Pr83 **Free parameter.** A parameter that can be stored by the user (word).
Pr84 **Free parameter.** A parameter that can be stored by the user (word).
Pr85 **Free parameter.** A parameter that can be stored by the user (word).
Pr86 **Free parameter.** A parameter that can be stored by the user (word).
Pr87 **Free parameter.** A parameter that can be stored by the user (word).
Pr88 **Free parameter.** A parameter that can be stored by the user (word).
Pr89 **Free parameter.** A parameter that can be stored by the user (word).

b90.X **Status of digital input X**. If X is greater than 3, this is a bit that can be stored by the user (b90.0 = converter enabled).

b91.Y **Status of digital output Y.** If Y is greater than 1 this is a bit that can be stored by the user. Parameter Pb91 is not saved and is set to 0 when the unit is powered on. The two digital outputs available can be used as input (b90.2, b90.3): in this case the corresponding output is set to 0 (b91.0, b91.1).

Pr92 **First timer of the PLC.** Every 6.144 ms, if Pr92 is not 0, it is decremented. If it is equal to 0, b99.0 is set to 1.

Pr93 **Second time of the PLC.** Every 6.144 ms, if Pr93 is not 0, it is decremented. If it is equal to 0, b99.1 is set to 1.

b94.0 **Force a double word formatted operation.** When the unit is powered on, this is 0. If it is set to 1, the first mathematical operation executed by the pico-PLC is done by using three double word type operands. After the execution of the operation b94.0 is automatically set to 0. If Pr60..Pr68 Pr110...Pr148 are used, the double word formatting is implicit.

b94.5 **First fast input disable** (b94.5=1). When the unit is powered on, this is 0.

b94.6 **Second fast input disable** (b94.6=1). When the unit is powered on, this is 0.

b99.0 **Status of the first timer.** Equal to 1 if Pr92 = 0.

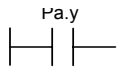
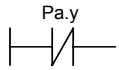
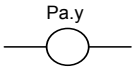
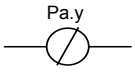
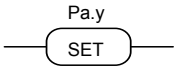
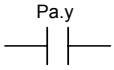
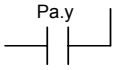
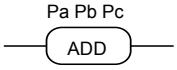
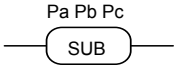
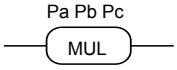
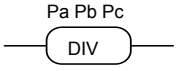
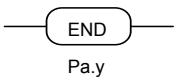
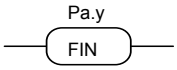
b99.1 **Status of the second timer.** Equal to 1 if Pr93 = 0.

b99.2 Equal to 1 if the result of the last PLC operation is negative.

b99.3 Equal to 1 if the result of the last PLC operation is 0.

b99.13 **PLC status**. Default=1. If set to 1, the PLC program is executed. If 0, the program is not executed, but the PLC instructions can be modified.

PLC INSTRUCTIONS

	**LD**	**Pa.y**	loads the y bit of the Pa parameter on the stack
	**LDN**	**Pa,y**	loads the negated y bit of the Pa parameter on the stack
	**OUT**	**Pa,y**	sets the y bit of the Pa parameter to the value loaded on the stack
	**OUTN**	**Pa,y**	places the y bit of the Pa parameter to the value of stack negating it
	**SET**	**Pa,y**	if the stack = 1, the y bit of the Pa parameter is set to 1
	RES	**Pa,y**	if the stack = 1, the y bit of the Pa parameter is set to 0
	**AND**	**Pa,y**	if the bit loaded on the stack contains the result of the logical AND operation between itself and the y bit of the Pa parameter
	ANDN	**Pa,y**	the bit of the stack contains the result of the logical AND operation between itself and the y bit of the negated Pa parameter
	**OR**	**Pa,y**	the bit loaded on the stack contains the result of the logical OR operation between itself and the y bit of the Pa parameter
	ORN	**Pa,y**	the bit on the stack contains the result of the logical OR operation between itself and the y bit of the negated Pa parameter
	**ADD**	**Pa, Pb, Pc**	if the bit on the stack = 1, the addition operation is executed on the parameters in which: Pc = Pa + Pb
	**SUB**	**Pa, Pb, Pc**	if the bit on the stack = 1, the subtraction operation is executed on the parameters in which: Pc = Pa – Pb
	**MUL**	**Pa, Pb, Pc**	if the bit on the stack = 1, the multiplication operation is executed on the parameters in which: Pc = Pa · Pb
	**DIV**	**Pa, Pb, Pc**	if the bit on the stack = 1, the division operation is executed on the parameters in which: Pc = Pa / Pb
	**END**		end of program
	**FIN**	**y, 0/1**	input with fast scanning

FUNCTIONAL DESCRIPTION

The pico-PLC program is scanned every 6.144 milliseconds. With this sampling, the input is first read, the two timers (Pr92 Pr93 b99.0 and b99.1) are updated, the user program is scanned and the output is updated. For this reason reading the input and setting the output can vary by 6.144 ms with respect to the physical event. If the microprocessor is overloaded with work (the operating mode is active, there are frequent serial requests and the PLC program is long), it may take more than 6.144 milliseconds to scan the entire PLC program.

All the instructions of the pico-PLC with the exception of the arithmetic instructions are single bit instructions. The available stack has a depth of only one bit.

The LD (LDN) instruction loads the bit defined as the operant on the stack with all the other logical instructions work on the stack itself. The arithmetic instructions are executed only if the stack bit is set to 1.

The truth table for the logical operations is given below for the convenience of the user.

AND logical operation		
bit A	bit B	result
0	0	0
0	1	0
1	0	0
1	1	1

OR logical operation		
bit A	bit B	result
0	0	0
0	1	1
1	0	1
1	1	1

The respective negative operations ANDN and ORN follow the same logic except that the negated value of the bit specified will be used.

12 bits from b90.4 to b90.15 are reserved on the PLC and can be stored. 14 additional bits from b91.2 to b91.15 are available on the PLC but cannot be stored. They are always set to 0 when the converter is powered on.

10 word parameters are also reserved. These are from Pr80 to Pr89. They can be stored and used as 5 double word parameters just as the 13 parameters from Pr151 to Pr163. The pico-PLC includes 9 constants for arithmetic operations. These are from Pr71 to Pr79 and can be the constants most used by normal applications.

When the arithmetic operations (ADD, SUB, MUL, DIV) are used, the operators are assumed to be words and are signed. If a double word operation is required, set b94.0 = 1 before the operation itself. After the operation the PLC will automatically set this bit to 0. The parameters Pr58...Pr69 and Pr110...Pr149 are treated as double words so that in an operation such as [ADD 71 72 64] the result –1 will be written in the double word Pr64:65 without having to set b94.0=1 before the operation. If Pr80=-1 and Pr81=0 the operation [ADD 80 72 64] will give the result Pr64:65=-1, while the same operation executed with b94.0=1 will assume Pr81 as the high word of the double word Pr80:81 and the result will be Pr64:65=65535. In the first case, operators other than Pr58...Pr69, Pr110...Pr149 are treated as words, while in the second case they are treated as double words.

In the mathematical operations on double words, the operands and the result are defined as follows: the parameter of the operand defines the least significant part while the most significant part is represented by the next word.

After every arithmetic operation, b99.2=0 if the result is positive and b99.2=1 if it is negative. In the same way b99.3=1 if the result is 0 and b99.3=0 if it is not 0. These settings remain active until the next arithmetic operation is executed (the operation is executed only if the stack bit is equal to 1). A mathematical operation can be executed by placing the result in one of the constant parameters (Pr71...Pr79) in order to set bit b99.2 and b99.3.

If the DIV operation is executed on a double word, the most significant part of the result contains the remainder of the division, that is, if b94.0=1 and the operation [DIV 79 77 80] is executed, the result will be Pr80=4 and Pr81=96.

The FIN instruction. Two instructions are available for the fast acquisition of inputs: in this case the scanning occurs at the rate of 512μs (normal scanning is at the rate of 6.144ms). If this is used, they must be the first instructions of the PLC. The first instruction FIN copies digital input 0 to the y bit of the Pb40 parameter (the second operand =0) or Pb150 (the second operand=1). The second FIN copies digital input 1 to the y bit of the pPb40 parameter (second operand=0) or Pb150 (second operand=1). If the value 2 is added to the second operand, the input must be negated before being copied. If an FIN instruction is inserted in a different position, it will not have any effect. The FIN instructions can be enabled/disabled using a bit for each FIN: the first FIN is enabled if b94.5=0; the second FIN is enabled if b94.6=0. The FIN instruction inserted in the PLC program after the first two instructions and in any case if it follows any instruction that is not a FIN instruction is ignored.

The user can make use of two timers, Pr92 and Pr93. To use the first timer load the time as a number of sampling (6.144 ms) into PR92. For example, Pr92=100 is equal to 614 milliseconds. Pr92 will automatically be decremented as time goes by and the b99.0 bit will remain set to 0 until the timer has expired. When Pr92=0, then b99.0=1. The second timer works the same way using the PR93 parameter and the b99.1 bit. Pr92, Pr93, b99.0 and b99.1 are updated only before the pico-PLC program is scanned.

The maximum number of instructions is 128. The arithmetic operations occupy the space of two logical operations. If they are used, the maximum number of instructions accepted is reduced.

The PLC program must always end with the END instruction.

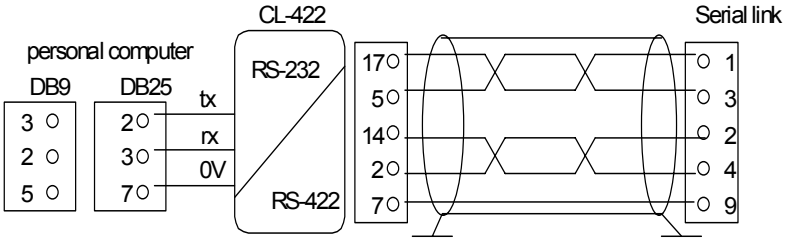
The pico-PLC program can be edited via serial link or directly using the keyboard. In this last case, in order to facilitate the modification of the program, if you want to delete an instruction, go to the instruction to be deleted and hit the [M] key. The type of instruction is then displayed. By holding down the [M] key and pressing the [-] key, the instruction will be deleted when both keys are released. If you want to add an instruction after the In06, go to the next instruction In07 and hit the [M] key. The type of instruction is then displayed. By holding down the [M] key and pressing the [+] key, the FIN instruction will be inserted when both keys are released. In this last case make sure that the program does not exceed the maximum limit of the instructions, otherwise the last instructions will be lost. The pico-PLC program can be edited or modified only when the PLC is in stop (b99.13=0).

4.2 Programming with MotionWiz

The **sLVD serial kit** is supplied to enable communication between a PC and the drive. The kit includes an RS-422/RS-232 converter, relative 230V~ power supply and serial connection cable. The enclosed communication software (supplied free of charge) designated **MotionWiz** has the following HW/SW requirements: 486 microprocessor or higher, *Windows* 3.1* or more recent version, mouse and serial port for drive connections. The main features of MotionWiz are:

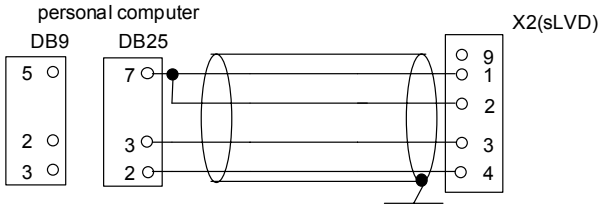
- serial connection of up to 32 drives
- reading and setting of basic parameters and drive commands
- reading and setting of commands and parameters of operating modes
- functional block diagrams
- pico-PLC program displayed as ladder diagrams
- display of pico-PLC program status during operation
- I/O status
- file storage of parameterisation including pico-PLC program
- uploading of parameterisation including pico-PLC program from a file that can be selected from among those previously stored
- oscilloscope function

PC - sLVD connection layout (sLVD serial kit):



To create line load (burden) resistances, jumper pins 2 and 6, and pins 4 and 7 on connector X2 of the last drive on the serial line.

If the PC is a battery powered laptop (i.e. not connected to ground) use the following connection layout:



To install MotionWiz open *WINDOWS**, insert the diskette in drive A, select the *File* menu in Program Manager and then the *Run.*option. Now run Setup.exe on [A:\] by typing the following string on the *Command line*: *A:\setup.exe* or by selecting the file with the *Browse...*button. The following installation procedure automatically creates a new icon for MotionWiz. Once the program is installed, launch it by double clicking the relative icon (or select the icon and then press ENTER). Set the parameters for activate the serial line.

- *Windows* and the Windows logo are registered trade marks or trade marks owned by Microsoft Corporation in the United States of America and/or other countries.

5 SERIAL INTERFACE

The serial communication of the converter is half-duplex, master-slave, using an asynchronous RS-485/RS-422 line. The converters take control of the line only if interrogated by the master.

The same serial line can be connected to up to 32 converters by setting a different serial address in each to the Pr27 parameter. It is also possible to set the transmission speed by using the Pr26 parameter as specified in the table below:

Pr26 (decimal base)	b/s	time-out (ms)
0	600	512
1	1200	256
2	2400	128
3	4800	64
4	9600 (*)	32
5	9600	32
6	19200	16
7	38400	12
8	57600	8

For the connection diagrams, see the section, *Connecting the serial line*.

5.1 Communication protocol

The column on the right in the table above shows the time-out value expressed in milliseconds for each communication speed. This is the time within which the message must be sent, beginning from the start of each message (STX). If a message is interrupted after this time, the converter ignores what has been received and waits for the beginning of a new message.

The message consists of several consecutive bits. The format of the bits is the following:

1 start bit
8 bit of data defined by a following byte enclosed within brackets
1 parity bit (even)
1 stop bit

The structure of the message is the following:

[STX] [CMD+ADDR] [BK+LUN] [PAR] [D0]... [Dn] [CHK]

where:

[STX] = $7E indicator of transmission start. If a field in the message different from STX assumes the value $7E, this field is followed by a 0 ($00) so that it will not be interpreted as an [STX].

[CMD+ADDR] = command and address of the peripheral device. This is never 0. This data is composed in the following way: the first 5 bits (bits 0-4) define the address of the converter (from 0 to 31); the remaining 3 bits (bits 5-7) define the type of message sent, as described in the following table:

CMD	bit 7	bit 6	bit 5	type of message
1	0	0	1	converter response
2	0	1	0	reading a pico-PLC instruction
3	0	1	1	writing a pico-PLC instruction
4	1	0	0	reading a parameter
5	1	0	1	writing a parameter
6	1	1	0	bit modification
7	1	1	1	writing a parameter to all the slaves

[BK+LUN] = the LUN field (first 3 bits) indicates the number of bytes of the data transmitted (a parameter or a PLC instruction); the values can range from 1 to 4. This value does not include eventual 0 characters ($00) which are inserted after the values that coincide with the character of transmission start ($7E). The length of each parameter is two bytes.
The BK field is represented by the 5 most significant bits and represents the 5 most significant bits of the parameter address.
[PAR] = write/read address of the parameter or PLC instruction.
The parameter address is the number of the parameter * 2 with 13 bit field: PAR represents the least significant eight bits of the address, the 5 most significant bits must be written in the BK field. The table used by electronic cam starts at the address 4096. The PLC instructions have the address from 0 up to 255.
[D0]... [Dn] = data transmitted.
[CHK] = 256 module sum of all the fields excluding the [STX] (checksum).

Message types
[CMD1] = is the response message of the converter to a data request. The response message has the following format:

[STX] [001+ADDR] [BK+LUN] [PAR] [D0]... [Dn] [CHK]

or it can be the confirmation message to a data write or data modify. In this case, the format is the following:

[STX] [001+ADDR]

where ADDR always identifies which converter is answering.

[CMD2] = is the read message of an instruction in the PLC area. The message has the following format:

[STX] [010+ADDR] [BK+LUN] [PAR] [CHK]

[CMD3] = is the write message to an instruction in the PLC area. The message has the following format:

[STX] [011+ADDR] [BK+LUN] [PAR] [D0]... [Dn] [CHK]

[CMD4] = is the read message of a parameter. The message has the following format:

[STX] [100+ADDR] [BK+LUN] [PAR] [CHK]

[CMD5] = is the write message of a parameter. The message has the following format:

[STX] [101+ADDR] [BK+LUN] [PAR] [D0]... [Dn] [CHK]

[CMD6] = is the change bit message of a byte parameter. The message has the following format:

[STX] [110+ADDR] [BK+LUN] [PAR] [D0] [D1] [CHK]

In this case LUN=2 or else two bytes are sent for the data. The first byte is the mask containing the 0s in the positions of the bits to be changed and 1s in the other positions, while the second byte contains 1s in the positions of the bits that are to be set to 1 and 0s in the other positions. The PAR address is that of the parameter (byte) where one or more bits are to be modified. If the parameter is a word and the bit to be modified is one of the first 8 (b0...b7): PAR = the parameter address; otherwise, if the bit to be modified is one of the upper 8 (b8...b15): PAR = the address parameter + 1.

[CMD7] = is the write message of a parameter to all converters connected to the serial line. The message has the following format:

[STX] [11100000] [BK+LUN] [PAR] [D0]... [Dn] [CHK]

The address of the peripheral device (ADDR) must be 0.

Notes:

- The parameters that are represented on the screen with decimals must be treated as complete values. For example, a value of 978.5 is read and written as 9785.
- All values that are receded by the $ symbol are to be understood as hex numbers.
- The value included inside the brackets identifies the base unit (byte) of the message.
- All messages must be terminated with a time-out which is a function of the speed, well defined to be considered valid and must have the exact parity and checksum.
- The converter responds to a request or to a data send only if the message has been received correctly. In the case of an error in the message, no response is transmitted. The only exception is message type 7 that is used to send data with a single message to all the converters connected to the serial line.

Initializing and managing the serial line

The converter is delivered with a 0 address (Pr27=0) and a speed of 9600 bps (Pr26=5).

To modify the configuration, first set the speed in Pr26, then the serial address in Pr27 and finally initialise it by issuing the command b42.3. Use the b99.15 command to store the configuration.

Each pico-PLC instruction occupies 2 or 4 bytes whose format is the following:

Since the maximum length of each instruction in 2 bytes and the total area available in the PLC is 256 bytes, the PLC program can have at the most 128 instructions.

Instruction	Code	Length (bytes)
LD Pa.y	0	2
LDN Pa.y	1	2
OUT Pa.y	2	2
OUTN Pa.y	3	2
AND Pa.y	4	2
ANDN Pa.y	5	2
OR Pa.y	6	2
ORN Pa.y	7	2
ADD Pa, Pb, Pc	8	4
SUB Pa, Pb, Pc	9	4
MUL Pa, Pb, Pc	10	4
DIV Pa, Pb, Pc	11	4
SET Pa.y	12	2
RES Pa.y	13	2
FIN Pb40.y/Pb150.y	14	2
END	15	2

The first 4 bits (b0..b3) of the first byte in each instruction contain the instruction code.

In the first 8 instructions in the table (LD… ORN) and the SET and RES instructions, the remaining 4 bit of the first byte (b4..b7) contain the value y, while the second byte contains the value Pa.

In the ADD, SUB, MUL e DIV instructions, the second byte contains the value Pa, the third byte the value Pb, and the fourth byte the value Pc.

In the END instruction, the second byte is not used.

In the FIN instruction, the fifth bit (b4) of the first byte selects the parameter: b4=0 if it refers to Pb40, b4=1 if it refers to Pb150; the sixth bit (b5) of the first byte is used for logical negation: b5=0 the bit is copied, b5=1 the bit is negated before being copied. The second byte of the FIN instruction contains the value of y.

If the FIN instructions are used, they must be the first instructions of the program and cannot be more than 2. They occupy the addressed from 0h to 3h. If a FIN instruction is inserted beginning at the 4h address or after any other instruction, the FIN instruction does not function and is ignored (NOP).

The instructions must follow each other beginning at address 0h and no byte can be left empty.

There is only one program and it is terminated with the END instruction.

Examples of using the serial line

In order to better understand how to implement the communication protocol on the serial line, some examples of each type of message are given below.

The values indicated are only indicative as examples.

First example: reading a 1 byte parameter

Suppose we want to read the value of the parameter Pr25 (release software) and that its value is 43. Suppose also that the converter has the serial address 0. The message to be sent is the following.

[$7E][$80][$01][$32][$B3]

The converter responds with the message:

[$7E][$20][$01][$32][$2B][$7E][$00]

Second example: reading a 2 byte parameter

Suppose we want to read the reference speed (Pr7) and that its value is 2000. Suppose also that the converter has the serial address 1. The message to be sent is the following:

[$7E][$81][$02][$0E][$91]

The converter responds with the message:

[$7E][$21][$02][$0E][$D0][$07][$08]

Third example: writing a 1 byte parameter

Suppose we want to select operating mode 1 (Pr31). Suppose also that the converter has the serial address 3. The message to be sent is the following:

[$7E][$A3][$01][$3E][$01][$E3]

The converter responds with the message:

[$7E][$23]

Fourth example: writing a 2 byte parameter

Suppose we want to set the rated current to 2.5 A (Pr33). Suppose also that the converter has the serial address 3. The message to be sent is the following:

[$7E][$A3][$02][$42][$19][$00][$00]

The converter responds with the message:

[$7E][$23]

Fifth example: setting a bit to 1

Suppose we want to send the command to save the PLC program (b99.14=1). Suppose also that the converter has the serial address 0. The message to be sent is the following:

[$7E][$C0][$02][$C7][$BF][$40][$88]

The converter responds with the message:

[$7E][$20]

Sixth example: setting a bit to 0

Suppose we want to disable the converter via software (b40.9=0). Suppose also that the converter has the serial address 0. The message to be sent is the following:

[$7E][$C0][$02][$51][$FD][$00][$10]

The converter responds with the message:

[$7E][$20]

Seventh example: writing a PLC instruction

Suppose we want to set the first instruction of the PLC as: LD 90.4. Suppose also that the converter has the serial address 0. The message to be sent is the following:

[$7E][$60][$02][$00][$40][$5A][$FC]

The converter responds with the message:

[$7E][$20]

6 CANBUS

A CanBus interface based on the physical layer ISO/DIS11898 is included on the SLVD converter. The Data link layer is the full CAN version 2.0 part A (ID 11 bit) and a subset of the application layer SBCCAN is used.

The CanBus on the SLVD has two functional modes.

The first functional mode is **real time mode**. This is to establish a real time digital link between 15 SLVDs and a control that executes the calculation of the trajectories and sends the position reference, the speed reference or both to the SLVDs which can change the actual position of the motors (b150.2=1). Real time mode is active when Pr31=15.

The second functional mode is **communication mode**. This is used to write or read every parameter of each SLVD connected to the bus (maximum of 15). This function is very useful when you want to sue the motion functions that have already been realized in the base software of the SLVD. Communication mode is automatically set when Pr31≠15.

The CanBus node must be set through Pr27 with values from 0 to 14 (*).

Transmission speed depends on Pr31, Pr48 e b150.4 as the following table:

Pr48	Pr31≠15	Pr31=15	b150.4	Max. length
0	125 kbps	1 Mbps	0	
0	125 kbps	500 kbps	1	
1	1 Mbps			40 m
2	500 kbps			100 m
3	250 kbps			250 m
4	125 kbps			500 m
5	50 kbps			1000 m
6	20 kbps			2500 m
7	10 kbps			5000 m

For bus length greater then about 1000 m bridge or repeater devices may be needed.

All changes in speed, address or function mode are activated using the b42.3 command or when the converter is powered on again.

(*) In the messages via CanBus, the node number is identified through Pr27+1, i.e. with values from 1 to 15

6.1 Description of the fields in real time mode

Cyclic message from the master to the SLVD

Cyclic data															
Data length			8/6/4 bytes												
Field Name			Position Reference					Speed Reference				Command			
Contents			Pr114:115 (32 bit)					Pr105 (16 bit)				Pr102 (16 bit)			
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	0	0	1	1	A3

A0:A3 SLVD slave address (Pr27+1), valid values 1..15.
Pr102 is used as a command and must be managed by the pico-PLC.
The data type depends on the message length as follows:

Data length	**Contents**	**Contents**	**Contents**
8	Position reference (4 byte)	Speed reference (2 byte)	Pr102 (2 byte)
6	Position reference (4 byte)	Pr102 (2 byte)	
4	Speed reference (2 byte)	Pr102 (2 byte)	

Synchronism message from the master to the SLVD

Synchronism message															
Data length			1 byte												
Field Name			Sync												
Contents			Sync type (8 bit)												
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
0	0	0	X	X	X	X	X	0	0	0	0	0	0	0	0

Type 0 synchronism (Sync = 0): every SLVD activates the speed references and the position references and stores the actual position of the motor; if b150.2=1 the drive answers with a "*cyclic reply*".

Type 1 synchronism (Sync = 1): stores the actual position of the motor; if b150.6=1 the drive answer with a "*cyclic reply*".

Cyclic message from the sLVD to the master

Cyclic reply															
Data length			6/7 byte												
Field Name			Address					Motor Position				Status			
Data			Pr27+1 (8bit)					Pr116:117 (32 bit)				Pr103			
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	1	0	1	0	A3

A0:A3 sLVD slave address (Pr27+1), valid values 1..15.
The Pr103 parameter is used as the status, if b150.3=0 all the 16 bits are sent, if b150.3=1 only the first 8 bits are sent.
If b150.0=1 the message is 8 byte long, and it isn't dependet on b150.3; Pr103 made up of 16 bit. When b150.1=1, the message has the following information:

Byte 1								Byte8							
7bit	6bit	5bit	4bit	3bit	2bit	1bit	0bit	7bit	6bit	5bit	4bit	3bit	2bit	1bit	0bit
MSB												In3	In2	In1	In0

Torque

MultiCyclic message from master to the sLVD

MultiCyclic data															
Data length			2,4,6,8 byte												
Field Name			Speed Reference0					Speed Reference 1				Speed Reference 2			Speed Reference 3
Contents			Pr105 (16 bit)					Pr105 (16 bit)				Pr105 (16 bit)			Pr105 (16 bit)
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
0	A1	A0	X	X	X	X	X	0	0	0	0	1	1	1	0

This message contains several data which are sent to several slave drives. One data (speed reference) is addressed for one drive, based on an addressing logic. The following table shows which information (speed reference, Pr105) is sent to which drive, based on the A0:A1(=group address) value.

A0:A1	**Speed reference 0**	**Speed reference 1**	**Speed reference 2**	**Speed reference 3**
0	Drive 1	Drive 2	Drive 3	Drive 4
1	Drive 5	Drive 6	Drive 7	Drive 8
2	Drive 9	Drive 10	Drive 11	Drive 12
3	Drive 13	Drive 14	Drive 15	

MultiSynchronism message from the master to the SLVD

MultiSynchronism message															
Data length			1,2,3,4 byte												
Field Name			Command 0			Command 1			Command 2			Command 3			
Contents			Pr102 (8bit)			Pr102 (8bit)			Pr102 (8bit)			Pr102 (8bit)			
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
0	0	0	X	X	X	X	X	0	0	0	0	0	1	0	0

Each drive receives and executes the speed reference and saves the actual motor position; if b150.2=1 the drive answers with a "*cyclic reply*".
This message is for several drives. The following table shows to which drive the "Command" (Pr102 – first 8 bit) is sent to.

Drive	**Command0**	**Command 1**	**Command 2**	**Command 3**
Drive1	YES			
Drive2	YES			
Drive3		YES		
Drive4		YES		
Drive5			YES	
Drive6			YES	
Drive7				YES
Drive8				YES
Drive9	YES			
Drive10	YES			
Drive11		YES		
Drive12		YES		
Drive13			YES	
Drive14			YES	
Drive15				YES

Each command is made up of 8 bit (Pr102) and it is sent to several drives. Each command value is set by the user through the pico-PLC of each drive.

Acyclic data write message or parameter request from the master to the SLVD

Acyclic data write or request															
Data length			7 byte												
Field Name			Cmd & Len					Data Address					Data		
Contents			5 bit command and 3 bit length					16 bit data address					32 bit data		
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	0	1	0	0	A3

A0:A3 SLVD slave address (Pr27+1), valid values 1..15.

Cmd & Len	**Sub-field**	**Value**	**Meaning**	
	Cmd [0..4]	0	Read request	
		1	Write	
		2	SET bit	Pr = Pr .OR. Data
		3	RESET bit	Pr = Pr .AND. (.NOT.Data)
		4	TOGGLE bit	Pr = Pr .XOR. Data
		5 – 31	Not use	
	Len [5..7]	0- 4	Number of significant bytes in the data field	

Data Address
This is the address of the parameter interested in the operation (parameter number * 2).
The PLC instructions have the address from 8192 up to 8447.
The electronic cam table have the address from 4096 to 4610.

Data
If the parameter is written, it contains the value of the parameter.
If one or more bits are modified, it contains the mask of the bits to be modified.
If the parameter is to be read, the field has no meaning.
If plc programme is written, it contains the instruction code (see the section *Serial interface*).

Acyclic response message to a parameter request from the SLVD to the master

Data reply															
Data length			5 bytes												
Field Name			Addr & Spare					Data							
Contents			Pr27+1					32 bit reply data							
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	1	1	0	0	A3

A0:A3 SLVD slave address (Pr27+1), valid values 1..15.

Broadcast write parameter message from the master to the SLVD

Broadcast data write															
Data length			7 bytes												
Field Name			Cmd & Len							Data Address				Data	
Contents			5 bit command and 3 bit length							16 bit data address				32 bit data	
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
1	1	1	X	X	X	X	X	0	0	1	0	0	0	1	1

Cmd & Len	**Sub-field**	**Value**	**Meaning**	
	Cmd [0..4]	0	Not used	
		1	Write	
		2	SET bit	Pr = Pr .OR. Data
		3	RESET bit	Pr = Pr .AND. (.NOT.Data)
		4	TOGGLE bit	Pr = Pr .XOR. Data
		5 – 31	Not used	
	Len [5..7]	0- 4	Number of significant bytes in the data field	

Data Address
This is the address of the parameter interested in the operation (parameter number * 2). The PLC instructions have the address from 8192 up to 8447.

Data
If the parameter is to be written, it contains the value of the parameter.
If one or more bits are modified, it contains the mask of the bits to be modified.
If plc programme is written, it contains the instruction code (see the section *Serial interface*).

Alarm message from the SLVD to the master

Error															
Data length			3 bytes												
Field Name			Addr							Error					
Contents			Pr27+1							Pr23					
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	1	0	0	0	A3

A0:A3 SLVD slave address (Pr27+1), valid values 1..15.

If the converter is in the alarm status, it will send this message on the bus (alarm 0 = no alarm).

To evaluate the minimum sampling time, use the following formula:

$$Tc_{min} = (Nr + Nt + 5) * 0.12$$

where: Tc_{min} is the minimum sampling time in milliseconds
Nr is the number of SLVDs that receive the reference
Nt is the number of SLVDs that transmit the feedback
The constant 0.12 is valid for 1 Mbps bus speed

Note 1: bit 41.15 can be used in "real time mode"; bit 41.15 is set to 1 every synchronism and multisynchronism message receiving via SBCCAN.
Therefore, it is possible to check the communication status between Master and Slave via CanBus through a simple pico-PLC program.
The pico-PLC code on the drive be as follows:

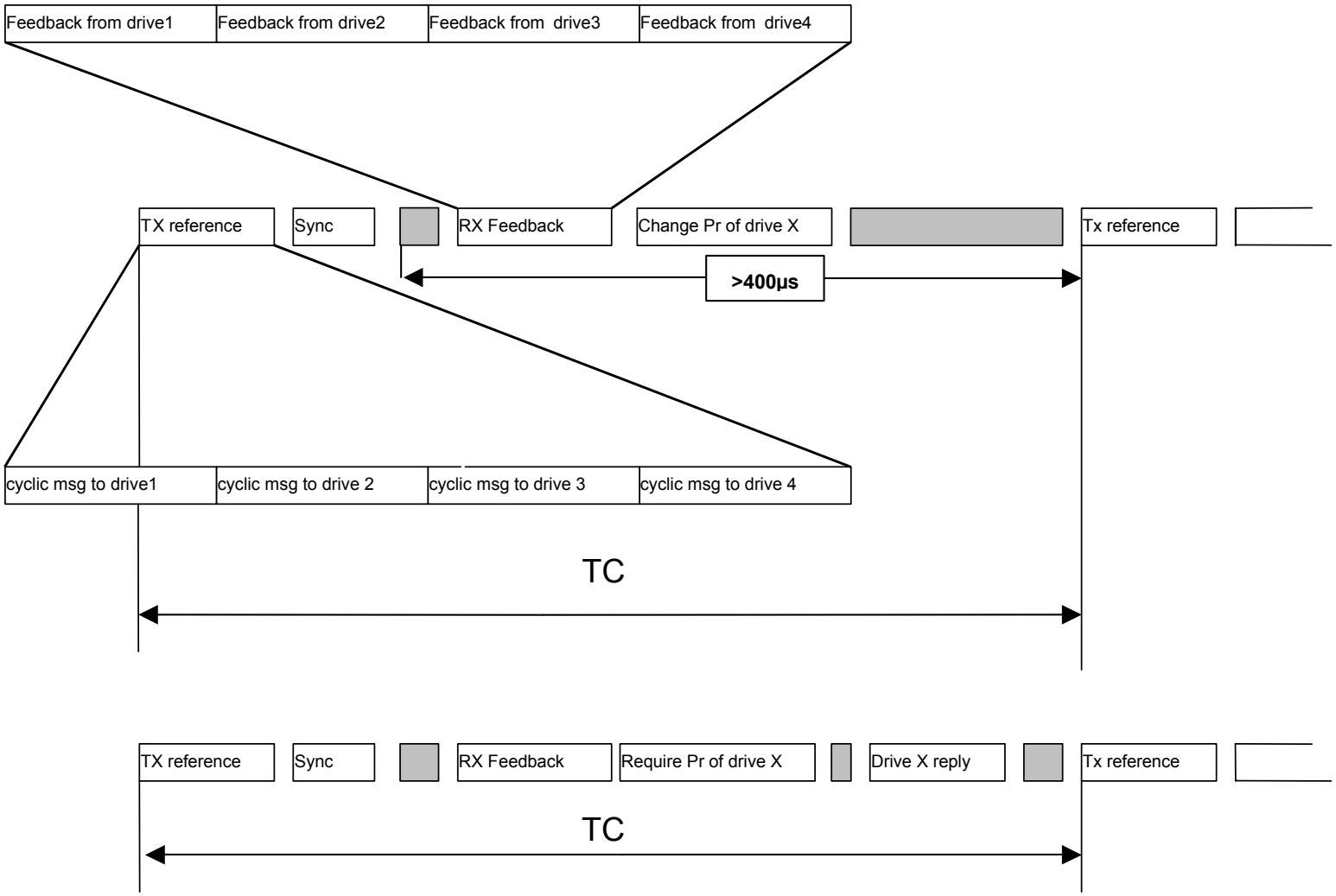
```
…
Ld 41.15
Out 41.5
Rst 41.15
…
```

If the check of the communication status between Master and Slave via CanBus is implemented into the drive pico-PLC, the test is executed every 6.144 [ms] (i.e. minimum execution time of pico-PLC program) or multiples.
Attention: both Pr103 (Status) and Pr102 (Command) must be set through a specific pico-PLC program into each drive.

Note 2: the Master can send the new reference data only if at least 400 [µs] passed from the last synchronism message, or if the response message has already been received.

The typical timing of the SBCCAN in real time mode is shown in the diagram on the next page:

SBCCAN


Feedback from drive1
Feedback from drive2
Feedback from drive3
Feedback from drive4
TX reference
Sync
RX Feedback
Change Pr of drive X
Tx reference
>400µs
cyclic msg to drive1
cyclic msg to drive 2
cyclic msg to drive 3
cyclic msg to drive 4
TC
TX reference
Sync
RX Feedback
Require Pr of drive X
Drive X reply
Tx reference
TC

6.2 Description of the fields in communication mode

Write or parameter request message from the master to the SLVD

data write or request															
Data length			7 bytes												
Field Name			Cmd & Len					Data Address				Data			
Contents			5 bit command and 3 bit length					16 bit data address				32 bit data			
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	A4	0	0	1	0	0	A3

A0:A4 SLVD slave address (Pr27+1), valid values 1..31.

Cmd & Len	**Sub-field**	**Value**	**Meaning**	
	Cmd [0..4]	0	Read request	
		1	Write	
		2	SET bit	Pr = Pr .OR. Data
		3	RESET bit	Pr = Pr .AND. (.NOT.Data)
		4	TOGGLE bit	Pr = Pr .XOR. Data
		5 – 31	Not used	
	Len [5..7]	0- 4	Number of significant bytes in the data field	

Data Address
This is the address of the parameter interested in the operation (parameter number * 2).
The PLC instructions have the address from 8192 up to 8447.
The electronic cam table have the address from 4096 to 4610.

Data
If the parameter is written, it contains the value of the parameter.
If one or more bits are modified, it contains the mask of the bits to be modified.
If the parameter is to be read, the field has no meaning.
If plc programme is written, it contains the instruction code (see the section *Serial interface*).

Response to a parameter request message from the SLVD to the master

Data reply															
Data length			5 byte												
Field Name			Addr & Spare					Data							
Contents			Pr27+1 (8bit)					32 bit reply data							
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	A4	0	1	1	0	0	A3

A0:A4 SLVD slave address (Pr27+1), valid values 1..31.

Broadcast write parameter message from the master to the SLVD

Broadcast data write															
Data length			7 bytes												
Field Name			Cmd & Len					Data Address					Data		
Contents			5 bit command and 3 bit length					16 bit data address					32 bit data		
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
1	1	1	X	X	X	X	X	0	A4	1	0	0	0	1	1

Cmd & Len	**Sub-field**	**Value**	**Meaning**	
	Cmd [0..4]	0	Not used	
		1	Write	
		2	SET bit	Pr = Pr .OR. Data
		3	RESET bit	Pr = Pr .AND. (.NOT.Data)
		4	TOGGLE bit	Pr = Pr .XOR. Data
		5 – 31	Not used	
	Len [5..7]	0- 4	Number of significant bytes in the data field	

Data Address
This is the address of the parameter interested in the operation (parameter number * 2). The PLC instructions have the address from 8192 up to 8447.

Data
When the parameter is written, it contains the value of the parameter.
If one or more bits are modified, it contains the mask of the bits to be modified.
If plc programme is written, it contains the instruction code (see the section *Serial interface*).

Alarm message from the SLVD to the master

Error															
Data length			3 bytes												
Field Name			Addr								Error				
Contents			Pr27+1								Pr23				
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	A4	0	1	0	0	0	A3

A0:A4 SLVD slave address (Pr27+1), valid values 1..31.

If the converter is in the alarm status, it will send this message on the bus (alarm 0 = no alarm).

6.3 Description of the fields Extended message set # 2

The extended message set 2 permits a memory area exchange between the master and the SLVD with both communication and realtime mode. The data exchange is synchronous: the data, transmitted from the master to the SLVD, are stored in a temporary buffer; when the master sends the synchronous message to all the drives, each SLVD copies the temporary buffer onto the writing block area and sends back the reading block area.

Block send message from the master to the SLVD

Block send															
Data length			8 bytes												
Field Name			Data												
Contents			64 bit of data												
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	1	0	0	0	0	0	1	A3

A0:A3 SLVD slave address (Pr27+1), valid values 1..15.

Synchronism message from the master to the SLVD

Block sync															
Data length			0 bytes												
Field Name															
Contents			No data												
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
0	0	0	X	X	X	X	X	1	0	0	0	0	0	0	0

Data received are stored from Pr80 to Pr83, and SLVD sends parameters from Pr84 to Pr87 by the following message:

Block reply message from SLVD to the master

Block reply															
Data length			8 bytes												
Field Name			Data												
Contents			64 bit of data												
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	1	0	0	0	0	1	0	A3

A0:A3 SLVD slave address (Pr27+1), valid values 1..15.

Note 1: as for the "real time mode", bit 41.9 is set to 1 every synchronism message receiving via SBCCAN.
Therefore, it is possible to check the communication status between Master and Slave via CanBus through a simple pico-PLC program.
The pico-PLC code on the drive be as follows:

```
…
Ld 41.9
Out 41.5
Rst 41.9
…
```

If the check of the communication status between Master and Slave via CanBus is implemented into the drive pico-PLC, the test is executed every 6.144 [ms] (i.e. minimum execution time of pico-PLC program) or multiples.

7 CAN Open

An alternative to the SBCCAN protocol is CANopen (to be expressly requested when placing your order: the drive may only have one protocol at a time) with the following implementations and functions:
The following objects are available based on CANopen's Pre-defined Connection Set:

Objects	Function code	COB-Ids	Index
NMT object	0000	0x00	-
EMERGENCY objec	0001	0x81-0xff	0x1014
SDO (tx) object	1011	0x581-0x5ff	0x1200
SDO (rx) object	1100	0x601-0x67f	0x1200
NMT Error Control (Node guarding)	1100	0x701-0x77f	0x100c- 0x100d

NMT object:

NMT state machine (DS301)

NMT Error Control & Boot Up Protocol:

- Boot Up
- Node Guarding – 39.14=1 for each receipt

EMERGENCY object :
Below is a description of emergency object implementation:

Emergency message dal Drive al master

Emergency message															
Data length			8 byte												
Field Name			Error code		Err. Reg			Drive address			Data				
Contents			16 bit code		8 bit error			8 bit address			32 bit reply data				
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	0	0	1	A6	A5	A4	A3

A0:A6 Drive address (Pr49), valid values 1..127.
An alarm message and two pop-up messages are available for this object, and each of these can be enabled or disables by setting the appropriate commands.
- Alarm message (enabled if b150.1=1)
- Target position reached (enabled if b150.5=1)
- Value motor captured (enabled if b150.7=1)

The alarm message, if enabled, is sent each time that the current alarm status (Pr[23]) changes, so that when a new alarm occurs (or when the alarms are reset) the value 0x01 is sent to the field Err.Reg, and the least significant byte of the Data field will contain the drive's alarm code.

The field Error Code will contain a specific code based on the different drive alarm:

- Er01 (over voltage) :	0x3210
- Er02 (under voltage) :	0x3220
- Er03 (over current) :	0x2340
- Er04 (encoder break) :	0x7303
- Er05 (over tempeature motor) :	0x4110
- Er06 (over tempeature drive):	0x4310
- Er07 (aux trip 1) :	0xff00
- Er08 (aux trip 2) :	0xff01
- Er10 (checksum PLC) :	0x6310
- Er11 (checksum Parametri):	0x6310
- Er14 (bracking resistance alarm) :	0x7113
- Er15 (default Parameter) :	0x6320
- Er16 (calibration alarm) :	0xff03
- Er17 (calibration alarm) :	0xff08

When alarms are reset with b99.10, Error code will be 0x0000 .

Two additional pop-up message not related to alarms can be enabled using command bits, and in this case the Err.Reg field will contain 0x00, while Error code will be 0xff05 for the target position reached message and 0xff06 for the value drive captured message. The Data field, in addition to the drive address, will, in the first case, contain the position reached by the motor and, in the second case, the captured position of the motor on the positive front of the input IN1.

The target position reached message is generated when the motor, after the target position is changed (in operating mode 13 Pb150.0=1, in operating mode 14 Pr102 not zero), will go to the target position at less than a tolerance set in Pr55 for at least a time of Pr88*2.048msec. When this message is enabled, the parameters b70.4, Pr55 and Pr88 are reserved for this task and are no longer available for their standard functions (servo error window and PLC program).

A user message can be sent by setting Pb70.12 to 1. In this case, Error Code will be 0xFF09 and the Data field will contain the value in Pr152:153.
Pb 70,12 will be reset to 0 once the message has been sent.

SDO(tx/rx) object

Below is a list of the objects in the device dictionary:

Object dictionary:

Index	
0x1000 : Device type (301)	RO
0x1001 : Error register	RO
0x1014 : COB-ID emergency obj	RO
0x1018 : Identity	RO
0x100c : Guard time	RO
0x100d : Life time factor	RO
0x1200 : Server SDO parameters	RO
0x2000 : Parameters area	RW
0x2001 : Parameters area set bit	RW
0x2002 : Parameters area reset bit	RW
0x2003 : Pico-PLC area	RW
0x2004 : I table area CAM (0..254)	RW
0x2005 : II table area CAM (255..256)	RW

As a general rule, sub_index 0 of indexes 0x2000..0x2002 represents the number of the sub_indexes available, and the subsequent (1..N) sub_indexes represent the parameter number concerned +1.

Sub_index 1 → Pr[0]
Sub_index 2 → Pr[1]
....
Sub_index n+1 → Pr[n]

Example of device memory access by SDO:
Write Pr80 to the drive:
You will need to write the object by SDO with index-sub_index 0x2000-0x51 (80+1).
If the number of bytes written is greater than two, the operation will also change the parameter Pr81.

Read Pr60 from the drive:
You will need to read the object by SDO with index-sub_index 0x2000-0x3d (60+1). The value returned will have a length of 4 bytes, the most significant of which will contain Pr61. If they are not needed, they can simply be discarded.

Set bit 4 of Pr40:
You will need to write the object by SDO with index-sub_inidex 0x2001-0x20 (40+1) with the value (0x0010) that represents in binary the bits involved in the operation, in our case bit 4.

Reset bits 4 and 5 of Pr40:
You will need to write the object by SDO with index-sub_inidex 0x2002-0x29 (40+1) with the value (0x0030) that represents in binary the bits involved in the operation, in our case bits 4 and 5.

Write bytes 0 and 1 of the pico-PLC area:
You will need to write the object by SDO with index-sub_index 0x2003-0x01 (0+1) with the value corresponding to the operating code of the instruction to add. For example, the instruction LD 90.0 requires the value 0x00 to be written in byte 0 and 0x5a in byte 1.

In addition to the objects described above, other objects are implemented based on CANopen's Predefined Connection Set, although these are not found in the object dictionary. These objects can be useful in accessing drive movement parameters.

PDO (tx/rx) object

PDO2 (tx/rx) object :
A protocol for parameter access, pico-PLC instructions, and drive cam table is implemented by exchanging the 8+8 read/write bytes of the PDO2, which, when the master receives the message PDO2 rx, interprets the contents of the first 7 bytes in accordance with the following format:

Acyclic data write message or parameter request from master to drive (PDO 2)

Acyclic data write or request															
Data length			7 byte												
Field Name			Cmd & Len					Data Address				Data			
Contents			5 bit command and 3 bit length					16 bit data address				32 bit data			
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	1	1	0	A6	A5	A4	A3

A0:A6 Drive movement address (Pr49), valid values 1..127.
Data For data writing, the field will contain the value of the parameter.
For bit change, the field will contain the mask of the bits to change.
For data reading, the field is insignificant.
For pico-PLC writing, it will contain the operating code of the instruction (see *Serial interface*).
Data Address This field is the address of the parameter involved in the operation (parameter number * 2). The PLC instructions have addresses in the range 8192 to 8447.
The cam table has addresses from 4096 to 4608.

Cmd & Len	**Sub-field**	**Value**	**Meaning**	
	Cmd [0..4]	0	Read request	
		1	Write	
		2	SET bit	Pr = Pr .OR. Data
		3	RESET bit	Pr = Pr .AND. (.NOT.Data)
		4	TOGGLE bit	Pr = Pr .XOR. Data
		5 – 31	Not use	
	Len [5..7]	0- 4	Number of significant bytes in the data field	

Acyclic response to a parameter request message from drive to master (PDO 2)

Data reply															
Data length			8 bytes												
Field Name			Addr & Spare			Data address		Data							
Contents			Pr27			16 address		32 bit reply data							
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	1	0	1	A6	A5	A4	A3

A0:A6 Drive address (Pr49), valid values 1..127.

PDO3 (tx) object :

This is used to generate a message with the data required to implement a reserved function.

PDO4 (tx/rx) object :

In this case, a parameter exchange function is implemented with the movement related to the logic functions managed by pico-PLC. In fact, for each transmission of PDO4 rx from the master to the drive node, the bytes contained in the message are interpreted as follows:

Parameter Pr80..83 write message from master to drive (PDO 4 rx)

Data receive															
Data length			8 bytes												
Field Name			Pr80			Pr81			Pr82			Pr83			
Contents			16 bit value			16 bit value			16 bit value			16 bit value			
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	1	0	1	0	A6	A5	A4	A3

A0:A6 Slave drive address (Pr49), valid values 1..127.

The bytes of the message are written to the corresponding parameters only if the function described is enabled by setting bit b99.5 to 1, and is done immediately prior to the next pico-PLC scan cycle (every 6.144 msec) from the reception of the PDO4 rx message.

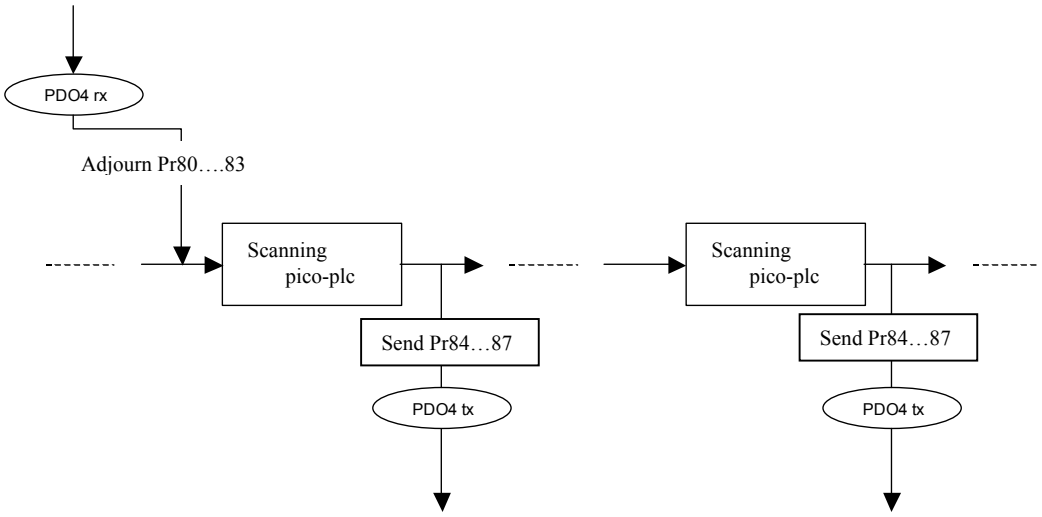
In much the same way as described above, the parameters Pr84..87 are sent through PDO4 tx by the slave to the master with the following format:

Parameter Pr84..87 read message from master to drive (PDO 4 rx)

Data send															
Data length			8 bytes												
Field Name			Pr84				Pr85			Pr86			Pr87		
Contents			16 bit value				16 bit value			16 bit value			16 bit value		
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	1	0	0	1	A6	A5	A4	A3

The bytes of the message containing the parameters Pr84..87 are sent to the master only if the function described is enabled by setting bit b99.5 to 1, and is done every Pr161 pico-PLC scan cycles (every 6.144 msec). If Pr161 is set to zero, the bytes are not sent even if b99.5=1. The data is sent when the pico-PLC program scan is complete.

The exchange structure implemented by the PDO4 allows access to the parameters Pr80..87 that do not have a predefined function in the converter but can be processed and interpreted with different functions and meanings according to the logic implemented in the pico-PLC program.



PDO1 (tx/rx) object :

Realtime Mode (Pr31 = 15):

In the same way as for the SBCCAN protocol, a real-time mode has been implemented (operating mode 15) which, for CANopen networks, uses PDO1 (rx/tx) for cyclical data exchange and the SYNC message for synchronizing the position loops. The message COB-IDs are different from SBCCAN execution for the purposes of compatibility with CANopen networks.

Cyclic message from master to drive (PDO1 rx)

Cyclic data															
Data length			8/6/4 bytes												
Field Name			Data												
Contents			position ref. 32 bits							speed ref. 16 bits			Pr102		
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
A2	A1	A0	X	X	X	X	X	0	1	0	0	A6	A5	A4	A3

A0:A6 Slave drive address (Pr49), valid values 1..127.

Pr102 is used as a command and must be managed by the pico-PLC.

Based on the length of the message, the data received is interpreted in the following way.

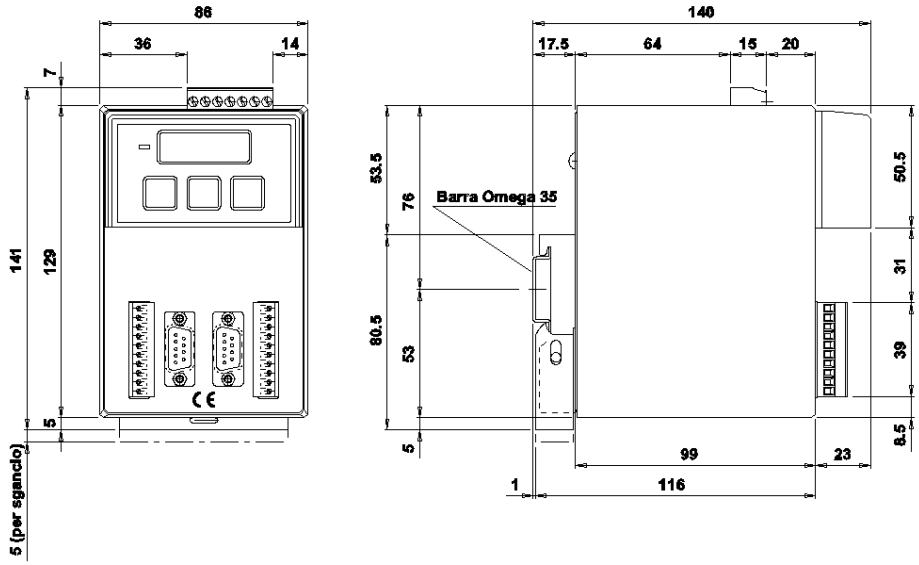
Data length			
8	Position reference (4 byte)	Speed reference (2 byte)	Pr102 (2 byte)
6	Position reference (4 byte)	Pr102 (2 byte)	
4	Speed reference (2 byte)	Pr102 (2 byte)	

Synchronism message from master to drive

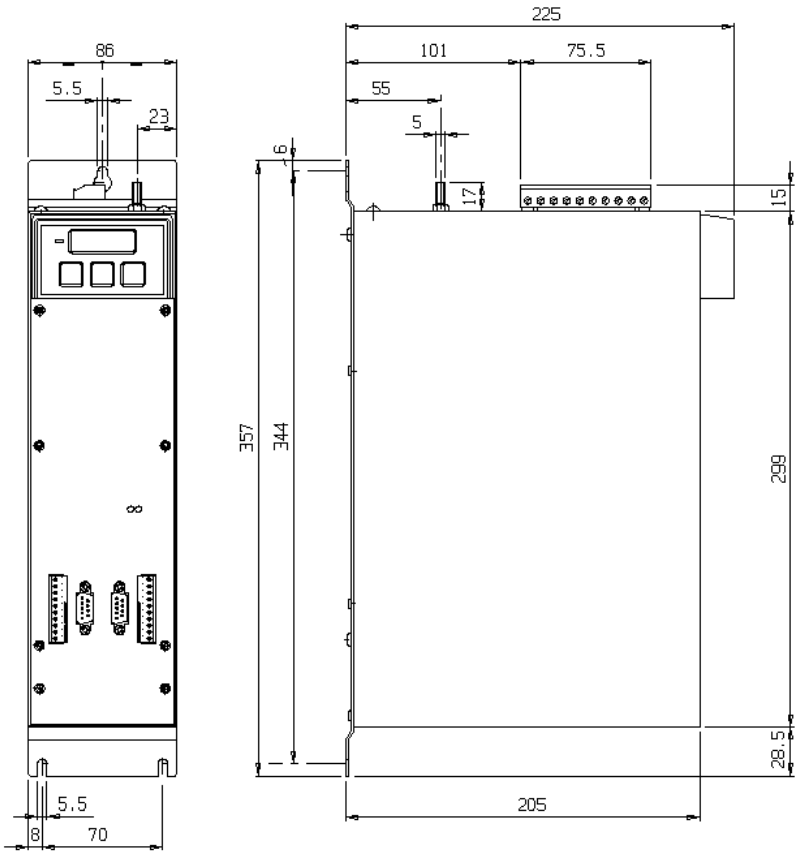
Synchronism message															
Data length			0 bytes												
Field Name															
Contents															
Identifier															
ID2	ID1	ID0	-	-	-	-	-	ID10	ID9	ID8	ID7	ID6	ID5	ID4	ID3
0	0	0	X	X	X	X	X	0	0	0	1	0	0	0	0

Upon receipt of the sync message, each drive activates the speed and position references and saves the current motor position. If b150.2=1, the drive responds with a message "*cyclic reply*".

8 Appendix A: Mechanical dimensions of the SLVD



(*) weight 1,1Kg

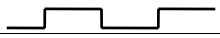
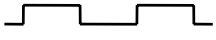


(*) weight 4,3Kg

9 Appendix B: Hardware features

Digital inputs		
Input impedance	7K	ohm
VH	15..30	V=
VL	0..3	V=
Digital outputs		
Type	PNP open collector	
VH	20..26	V=
Io for a single output	100	mA
Maximum total current	500	mA
Analogue reference		
Type	differential	
Impedance	20K	ohm
Range	± 10	V=
CMMR	> 60	dB
Resolution	15	bit
Auxiliary analogue inputs		
Type	differential	
Impedance	250K	ohm
Escursione	± 10	V=
CMMR	> 40	dB
Resolution	10	bit
Analogue outputs		
Type	single ended	
Maximum i/o	1.5	1.5
Range	± 4.5	± 4.5
Resolution	10	10

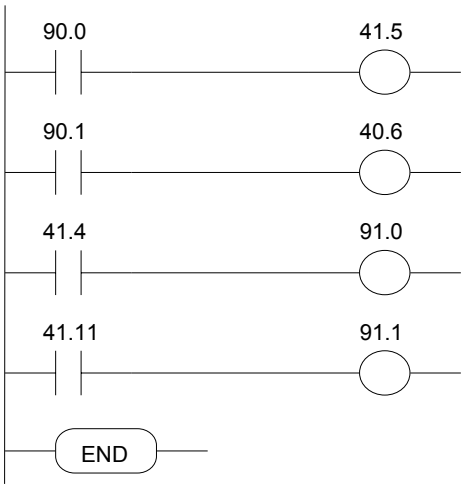
10 Appendix C: Conventions

Reference	Positive
Motor shaft movement (motor shaft view)	
Torque	Positive
Resolver counter	Increments
Encoder output	A B
Tachometer signal	Positive
Iu	$couple \bullet \sin(\vartheta)$
Iv	$couple \bullet \sin\left(\vartheta + \frac{2 \bullet \pi}{3}\right)$
Positive auxiliary input	Pr22 positive
Pr38 positive	Positive auxiliary analogue output
Encoder In. A B 	Increment counter
frequency A  direction B	Increment counter

11 Appendix D: Software timing

Period	Task
128 μs	Current control
512 μs	speed control
	Fast operating modes management
	Torque limits management
	Speed reference management
	Braking resistor management
	FIN management
2.048 ms	Slow operating modes management
6.144 ms	Thermal motor image
	digital inputs
	program scanning pico-PLC
	digital outputs
49.152 ms	Speed windows management

12 Appendix E: Default program for the pico-PLC



LD	**90.0**	digital input 0 used to power the drive
OUT	**41.5**	
LD	**90.1**	digital input 1 used for the stop function
OUT	**40.6**	
LD	**41.4**	digital output 0 indicates that the converter is OK
OUT	**91.0**	
LD	**41.11**	digital output 1 indicates that the thermal motor image is active
OUT	**91.1**	
END		end of the program

13 Appendix F: Flash information

- TO SAVE USA IL b99.15 PARAMETERS
- TO SAVE THE PLC USA IL b99.14 PROGRAM
- TO CHANGE THE INSTRUCTIONS, PLC b99.13 MUST BE 0
- WHEN THE OPERATING MODE IS CHANGED, YOU MUST USE b99.11 TO LOAD THE DEFAULT PARAMETERS (b40.2 MUST BE 0)
- BEOFRE CHANGING Pr31, BE SURE THAT b40.2=0
- THE SPEED REFERENCE WILL BE LIMITED TO THE VALUE OF Pr32
- USING THE TORQUE CONTROL, Pr2 AND Pr3 MUST BE SET TO 1000
- TO USE THE ACTIVE OPERATING MODE, b40.2 MUST BE 1
- IF YOU CANNOT MODIFY THE READ-WRITE PARAMETERS USING THE KEYPAD, BE SURE THAT E b99.7 IS 0. IF IT WAS 0, PROBABLY THE SAME PARAMETERS WERE MODIFIED BY THE PLC PROGRAM.

14 Appendix G: Alarms

Error Code sLVD: 0	**Drive OK**
Error Code sLVD: 1	**Over Voltage** on the D.C. Link. Check the three-phase power line. Check the break circuit and the braking resistor
Error Code sLVD: 2	**Under Voltage** on the D.C. Link. Check the three-phase power line.
Error Code sLVD: 3	**Over current**. Check for any mechanical blockage and make sure the motor is the appropriate size for its current use. Check the motor connections and for any phase-phase or phase-ground short-circuits. Check the machine speed and the service cycle. Make sure a line trap isn't connected to the motor!
Error Code sLVD: 4	**Resolver**. Check the connections of the resolver and the connectors on both sides (drive-motor).
Error Code sLVD: 6	**Drive Over Temperature.** Check the cooling fans and for any restrictions to air flow. Check the breaking cycle. Check the environmental temperature of the electrical control panel where the drive is installed, as well as the external room temperature.
Error Code sLVD: 7	**External alarm**
Error Code sLVD: 8	**Auxiliary alarm**
Error Code sLVD: 10	**Check sum PLC**
Error Code sLVD: 11	**Check sum parameter**
Error Code sLVD: 14	**Brake overload.** Braking resistance use overload
Error Code sLVD: 15	**Default parameter**
Error Code sLVD: 16	**Calibration error**
The sLVD's LED display shows decimal points on all characters	The drive goes in I^2T mode due to an overload (it required more current that was available). Check: - The cables between motor and **sLVD** (there should be no inverted phases). Take special care with motors with terminals rather than the connector: it's easy to make a mistake. Adhere strictly to the wiring diagrams.

15 Appendix H: external bracking modul

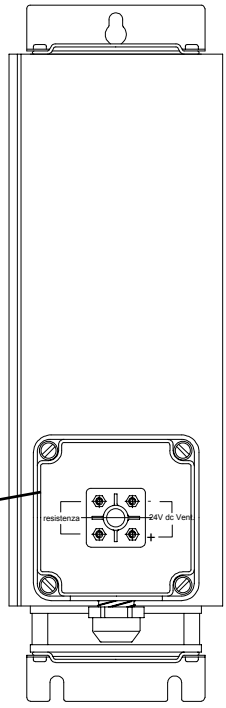
TECHNICAL CHARACTERISTICS

Resistance value:	RFE1 = 40 ohm, RFE2 = 27 ohm
IP protection	20
Max power dissipated	1000 W
Max ambient temperature	45° C
Delta T	90° C
Weight	2,5 Kg
Ventilation power supply	24 V=

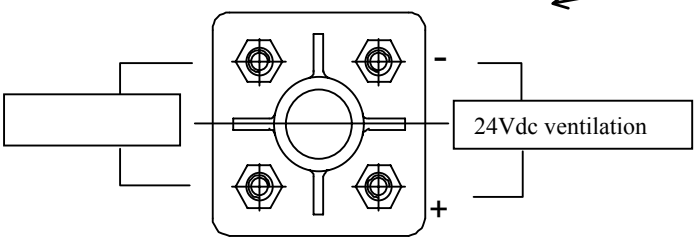
INSTALLATION

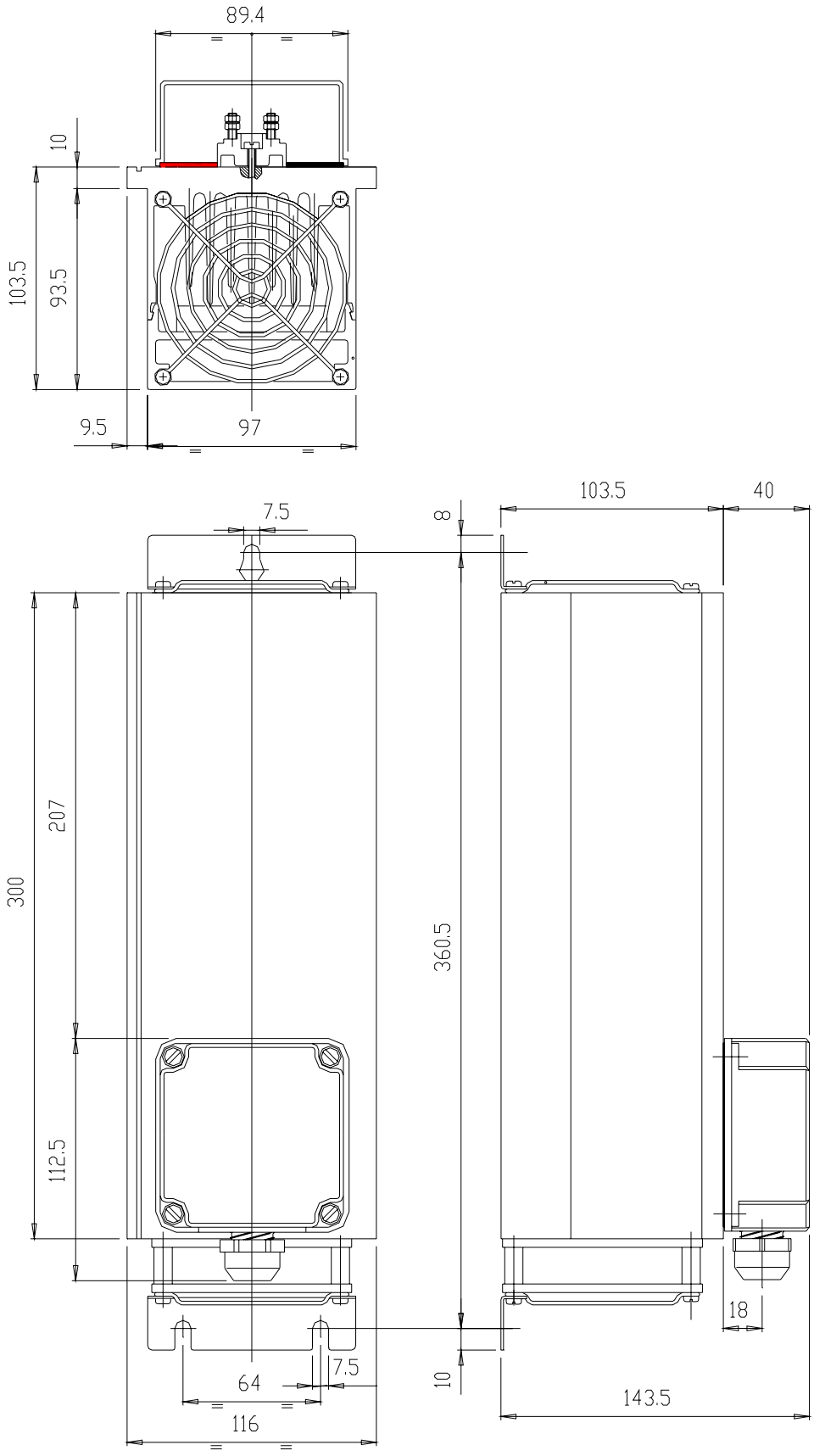
The RFE1 or 2 breaking module must be installed vertically as shown. A four-pole 4mm^2 cable must be used for the connection.

The 24v power supply used for the ventilator can cause disturbances. It is therefore a good idea not to use the same power line for electronic devices. The cable should not be longer than 4m. For the connection to the drive, see the related chapter in the converter manual and use a 30A thermo-magnetic switch.



Terminal pins REF1




89.4
10
103.5
93.5
9.5
97
7.5
8
103.5
40
300
207
112.5
360.5
18
64
7.5
10
116
143.5

16 Revision history of the User Manual

Rev. 0.0	August 1999. Preliminary version.
Rev. 0.1	January 2000.
Rev. 0.2	January 2000. Output cam programmer (*Additional useful functions*).
Rev. 0.3	April 2000. Operating mode 13: b150.6. CAN Bus: Pr48 for bus speed, Extended message set #2.
Rev. 0.4	August 2000. Position loop: new parameters Pr51, Pr58:59. Operating mode 14: new value limits for Pr110:111, Pr112:113. Operating mode 14: new b150.2.
Rev. 0.5	September 2000. Max value Pr44 = 2500.
Rev. 0.6	February 2001 New resolver cable requirement : insulated and twisted pairs.
Rev. 0.7	September 2001 Value comparators. These functions are enabled ONLY with operating mode 13 and 14
Rev 0.8	November 2001 Chapter 2.5 Add characteristics of 24V power supply Set and complete the layout structure of the document
Rev 0.9	March 2002 Grounding bar instructions revised.
Rev 1.0	September 2002 User manual version as Italian version rev. 1.0 September 2002 SW rel. 19.
Rev 1.1	January 2003 EMC and cable connections modifications Manual version as Italian version rev. 1.1 January 2003 SW rel. 19.
Rev 1.2	February 2003 Updated the "Main Hardware Features" table. Added address list.
Rev 1.3	February 2004 Data for the UL certification External braking resistance
Rev 2.4	March 2004 Declaration of conformity Adjourned figures and drawings (connections, power, motor, resolver, signal, Can) Adjourned Pr36, 49, 40.8, 42.6, 42.7, 99.4, 70.7 Adjourned signal connectors layout Adjourned main block diagram Adjourned position loop Adjourned OPM 13 diagram Value capture FBK encoder CAN and incremental encoder Adjourned SBCCAN

Adjourned CAN OPEN
Adjourned keyboard
Motion WIZ
Adjourned alarms

Rev 2.5 April 2004
Insert new draw about external braking resistance

Rev 2.6 July 2004
Adjourned SBCCAN: in communication Mode the address is by A0:A4

For other informations log into website www.sbcelettronica.com. *Aranges to the manual data can be made by the manufacturer without advance notice. The data shown in the manual correspond to the specifications relating to the revision date*

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